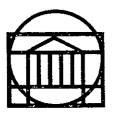
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RESEARCH LABORATORIES FOR THE ENGINEERING SCIENCES



SCHOOL OF ENGINEERING AND APPLIED SCIENCE

UNIVERSITY OF VIRGINIA

Charlottesville, Virginia 22901

A Final Report

OPTIMIZATION OF MLS RECEIVERS FOR MULTIPATH ENVIRONMENTS

NASA Grant NSG 1128

Submitted to:

NASA Scientific and Technical Information Facility
P. O. Box 8757
Baltimore/Washington International Airport

Submitted by:

G. A. McAlpine Associate Professor

J. H. Highfill III Senior Scientist

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SECTION I

INTRODUCTION

This is the final report of research under Grant NSG 1128, awarded to the University in December 1974. The project is concerned principally with the angle-tracking problems in Microwave Landing System (MLS) receivers, the goal of the research being a receiver design capable of optimal performance in the multipath environments found in air terminal areas. The scope of the work included various theoretical and evaluative studies associated with the project goal, e.g.

- i. Signal model development
- ii. Derivation of optimal receiver structures
- iii. Development and use of computer simulations for receiver algorithm evaluation

and also, at least initially, the development of an experimental receiver for flight testing. Reference is made to the progress reports [1-5] for details of the research. This report provides an overview of the work and a summary of principal results and conclusions.

During the 1976-77 annum a study of the DME was also undertaken along with the ongoing angle receiver research. The DME work included some preliminary theoretical analysis but mostly simulation studies of the various designs, i.e. fixed threshold, adaptive threshold and delay and compare DME receivers. The simulations showed the delay and compare receiver to be the most robust of the three designs simulated. The DME study was peripheral to the focal research on the angle receiver and is not discussed further in this report. Reference is made to [4, pp. 51-100] for more detail.

The early study established that multipath propagation in air terminal areas is due principally to reflections from hangars and other buildings, other aircraft and the ground -- all cases where the multipath interference is very nearly specular in nature and either an actual or virtual specular point can be identified. A math model for the received signal in such a case contains parameters which, together with selected time derivatives, constitute a vector which is easily conceptualized into the "state" of a state space model of the problem dynamics. And the latter provides the mathematical framework necessary for applying recursive state estimation techniques to the optimal receiver design problem. This was the approach taken in the research.

Two algorithms resulting were studied extensively:

- i. An Optimal receiver: The state vector included signal-to-noise ratios, angular coordinates, angular rates, the phase difference and scalloping frequency parameters.
- ii. A Suboptimal receiver: A structure similar in some respects to the optimal receiver but the phase difference and scalloping frequency parameters were not estimated.

Both algorithms generally outperformed in simulation a "threshold receiver" design which was approximately representative of the current Phase III Receiver. The Optimal design generally was the best, at least when the scalloping rate was less than half the angle function repetition rate and hence the phase difference parameter could be tracked successfully. The suboptimal design, at least in the simulation, suffered from extremely complex and length computations. The optimal design (and presumably the suboptimal design, would also) exhibited a

high sensitivity to error in the (presumed) beam width of the MLS ground antenna. These and other simulation results are discussed at length in the report, and approaches are suggested for possible improvements in performance.

Some considerations relating to an experimental receiver design are also offered.

SECTION II

SIGNAL MODEL AND ESTIMATOR DESIGNS

The signal available to the processor is a log video signal with bandwidth approximately half that of the i-f channel of the receiver. We begin at this point with the adaptation of this signal, in part A below, for use by the processor. Part B presents a state space model of the evolving problem geometry. Part C describes the general approach used to optimal receiver design, and Part D develops specific designs studied in the research. The reader is assumed to be familiar with the MLS system concepts and signal formats; for this orientation, refer to [6], [7] and [8].

A. THE AMPLITUDE-SQUARED ENVELOPE SIGNAL

The receiver log-envelope signal, a continuous-time signal within a scan, is sampled throughout a window on each semi-scan (centered on the expected centroid of the direct path pulse) at a sampling rate approximately equal to the i-f bandwidth and then suitably exponentiated and squared; the resulting J samples of the amplitude-squared envelope taken within a given scan are then normalized to a suitable measure of receiver noise power and assembled into an observations, or measurement, vector \mathbf{u} , which clearly is nonlinear in the problem parameters of interest and also corrupted non-additively by receiver noise. Specifically, for the kth scan, $\mathbf{k}=0,1,2,---$, and in terms of a discrete-time variable τ_j local to the scan, and assuming the presence of a direct-path component, a single multipath component and receiver noise, the jth component of \mathbf{u} , say \mathbf{u}_j , $\mathbf{j}=1, ---$, J is modeled as follows:

$$\begin{aligned} \mathbf{u}_{j} &= \{ \alpha_{\mathbf{p}} [\theta - \theta_{\mathbf{A}}(\tau_{j})] + \alpha_{\mathbf{R}} \mathbf{p} [\theta_{\mathbf{R}} - \theta_{\mathbf{A}}(\tau_{j})] \cos \beta_{j} + \mathbf{n}_{c_{j}} \}^{2} \\ &+ \{ \alpha_{\mathbf{R}} \mathbf{p} [\theta_{\mathbf{R}} - \theta_{\mathbf{A}}(\tau_{j})] \sin \beta_{j} + \mathbf{n}_{s_{j}} \}^{2} \end{aligned}$$

$$(2.1)$$

where

$$\alpha = \alpha(k) = \text{direct path signal-to-noise ratio}$$
 (2.2)

$$\theta = \theta(k) = \text{angular coordinate of own A/C}$$
 (2.3)

$$\alpha_{R} = \alpha_{R}(k) = \text{multipath signal-to-noise ratio}$$
 (2.4)

$$\theta_R = \theta_R(k) = \text{angular coordinate of reflector specular point (2.5)}$$

 β_j = $\beta(k,\tau_j)$ = direct path-to-multipath phase difference at the jth sample of the kth scan, propagating as follows:

$$\beta_{j} = \beta(k) + w_{sc}\tau_{j} + \frac{w_{sc}}{2}\tau_{j}^{2} + ---$$
 (2.6a)

where

 $\beta(k)$ = phase difference at the start of the kth scan, propagating similarly, i.e.

$$\beta(k+1) = \beta(k) + w_{sc} T_k + \frac{\dot{w}_{sc}}{2} T_k^2 + ---$$
 (2.6b)

in which

$$T_k = time interval, kth-to-(k+1)th scans.$$
 (2.7)

 \mathbf{w}_{sc} = the scalloping rate (also derivatives may be

$$\theta_{A}$$
 (.) = the transmitting antenna scanning function (2.9) (see equation (2.124) below)

$$p[.] =$$
the transmitting antenna selectivity function (2.10)

(square root of power density at a constant radius) and

$${}^{n}_{c}$$
, ${}^{n}_{s}$ are independent Gaussian random variables j yith mean zero, variance 0.5. (2.11)

This model neglects second-order effects ([3], p. 9) chiefly

- a. Doppler effects not influencing the scalloping rate
- b. Differential propagation delays (e.g. ($\frac{r_{\text{reflect}} r_{\text{direct}}}{c}$), which tend to distort the mirror symmetry that exists between the TO-, FRO-scan signals.

B. THE STATE-SPACE MODEL

The various parameters appearing in u_j , (2.1) above, together with time derivatives of interest, are assembled into an N_s -dimensional state vector, x, modeled as the solution of a suitable linear difference equation evolving in discrete-time, from scan-to-scan, and excited by a white, zero-mean random process, representing external influences. Hence, the composite generator-of-observations model is taken as a state space formulation with form as follows:

$$x(k+1) = F(k)x(k) + G(k)z(k)$$

 $u(k) = h(x(k),n(k))$ (2.12)

where

$$x(k) = state N_s-vector$$
 (2.13)

z(k) = a representation of the various external influences on the modeled environment, taken as an M-vector random process, white with mean zero and covariance matrix Q(k),

$$Q(k) \stackrel{\triangle}{=} \langle z(k)z^{T}(k) \rangle \tag{2.15}$$

$$F(k)$$
 = state 1-step transition matrix (2.16)

 $G(k) = an N_S x M input constraint matrix of rank M, where...$

$$M \leq N_{c} \tag{2.17}$$

$$u(k) = observations J-vector$$
 (2.18)

- n(k) = a 2J-vector of the quadrature components $n_{c,j}$ $n_{s,j}$ of receiver noise associated with the J samples of the noisy envelope (n(j)) and n(k) are independent if $j \neq k$). (2.19)
- $h(\cdot, \cdot)$ = a nonlinear vector-valued function of its arguments, constructing u(k) as a J-vector of envelope samples $u_{\hat{j}}, \text{ equation (2.1)}. \tag{2.20}$

C. THE ESTIMATION APPROACH

In developing a procedure for estimating the angular coordinate θ , it was clear from (2.1) that performance would be better if more of the state variables than just θ were estimated. It was also clear that not all of the state variables influence the vector $\mathbf{u}(\mathbf{k})$ of observation's taken within a single scan; in the present formulation, for example, θ and θ_R are considered constants during the active scan, hence $\dot{\theta}$ and $\dot{\theta}_R$ are absent from (2.1), nevertheless they are necessarily included as variables in the state vector to afford modeling tractably a varying geometry over a sequence of scans. The functional dependence of $\mathbf{u}(\mathbf{k})$ on only a subset of the state variables posed a choice:

- 1. Estimate only the subset of state variables associated with $\mathtt{u}(\mathtt{k})$.
- Estimate the full state vector x(k).

The first option very likely would result in severe degeneration in performance, during signal fades, including possibly loss of lock. The benefits promised by a modest filter memory, however, (represented by rate estimates in a receiver state estimator, e.g.) prompted the second choice, and we began to consider the criterion under which a suitable

estimate of the full state x(k) could be calculated recursively, given the complexity of the observations.

Ideally, given a sequence of observations u, (2.12b), say from some initial scan through the present (kth) scan, represented as follows:

$$U(k) \stackrel{\triangle}{=} \{u(1), u(2), ---, u(k)\}, \tag{2.21}$$

we might adopt as a candidate criterion of performance the mean square error criterion and seek to calculate the conditional mean $\langle x(k) | U(k) \rangle$ as a basis for an optimal MLS receiver design. Without loss of generality, however, the conditional mean can be written as

$$\langle x(k) | U(k) \rangle = \langle x(k) | U(k-1) \rangle + \langle E(k) | U(k) \rangle$$
 (2.22)

where

$$\langle x(k) | U(k-1) \rangle = F(k+1) \langle x(k-1) | U(k-1) \rangle$$
 (2.23)

is the extrapolation of the prior estimate to the present, and $\langle E(k) | U(k) \rangle$ is the conditional mean of the error

$$E(k) \stackrel{\triangle}{=} x(k) - \langle x(k) | U(k-1) \rangle \qquad (2.24)$$

in the extrapolated estimate (2.23). Hence, via (2.22), a conditional mean receiver is essentially equivalent to a calculation of $\langle E(k) | U(k) \rangle$, a task which, generally,

- 1. As the notation suggests, may involve individually each and every observation constituting the sequence U(k), and in addition,
- 2. May not even be computable in a finite number of operations, or even easily approximated.

A class of notable exceptions exists in which not only is $\langle E(k) | U(k) \rangle$ computable or easily approximated, but all the historical information in dated observations necessary for the calculation of $\langle E(k) | U(k) \rangle$ is

carried in the extrapolated prior state estimate $\langle x(k) | U(k-1) \rangle$, (2.23); that is $\langle E(k) | U(k) \rangle$ can be written

$$\langle E(k) | U(k) \rangle = f(\langle x(k) | U(k-1) \rangle, u(k)), \text{ for some } f(\cdot, \cdot).$$
 (2.25)

Two examples are the following:

- 1. The Kalman filter, applicable when h(x,n) is linear in both x and n, gives an exact calculation of $(\langle E(k)|U(k)\rangle;$
- 2. The Extended Kalman filter, applicable when h(x,n) represents an additive corruption of the observations by n, gives an approximat calculation of $\langle E(k) | U(k) \rangle$ when h(x,n) is nonlinear in x.

Because of the complexity of the observation h(x,n) [recall h_j , (2.1)] and the computability requirement (for simulation and also, potentially, hardware), the estimation approach used in this research was, of necessity, an approximation. An adaptation of the preceding was used, producing a state estimate (generally now suboptimal), denoted $\hat{x}(k|k)$ to distinguish it from the exact conditional mean, and obtained, as follows:

$$\hat{x}(k|k) = \hat{x}(k|k-1) + \hat{\xi}(k|k)$$
 (2.26)

where

$$\hat{x}(k|k-1) = F(k-1)\hat{x}(k-1|k-1)$$
(2.27)

and $\hat{\xi}(k \mid k)$ is a "suitable" estimate to be defined below, of the error $\hat{\xi}(k)$ in $\hat{x}(k \mid k-1)$, given $\hat{x}(k \mid k-1)$ and u(k), where

$$\xi(k) \stackrel{\triangle}{=} x(k) - \hat{x}(k|k-1) \tag{2.28}$$

The estimate $\hat{\xi}(k|k)$ will be functionally dependent only upon $\hat{x}(k|k-1)$ and u(k). A final error definition needed and an easily proved result of interest are, as follows:

$$e(k) \stackrel{\Delta}{=} \xi(k) - \hat{\xi}(k|k) \tag{2.29}$$

$$= x(k) - \hat{x}(k|k)$$
 (2.30)

i.e., the error in the estimate $\hat{\xi}(k\,|\,k)$ is the residual error in the updated state estimate $\hat{x}(k\,|\,k)$.

Since the observations u(k) are functionally dependent upon only a subset of the state variables, the calculation of $\hat{\xi}(k|k)$, i.e. the estimation of the error $\xi(k)$ in $\hat{x}(k|k-1)$, given $\hat{x}(k|k-1)$ and u(k); was accomplished in 2 stages, characterized respectively as the Scan Data Processor (SDP) and the Tracking Loop Filter. The SDP essentially does a curve-fitting of a noiseless, internal version of the observations with the noisy, actual ones, calculating perturbations (error estimates) of the associated elements of $\hat{x}(k|k-1)$ to improve the fit. The Tracking Loop, closed around the SDP in a conventional recursive structure, develops on estimate of the full error vector $\xi(k)$, taking the assumed state evolution dynamics into account. A detailed discussion of these two stages is given below.

The approach taken was modified, in part, by two factors, as follows:

1. The presumed low-bandwidth of the state evolution model wrt the repetition rate, implying, quantitatively,

$$x(k) \sim F(k-1)x(k-1)$$
 (2.31)

(i.e. G(k-1)w(k-1) in (2.12) is small).

2. The "tracking" nature of the estimation task implying, presumably,

$$x(k) \stackrel{\sim}{\sim} \hat{x}(k|k) \tag{2.32}$$

(i.e. the estimation error e(k), (2.31), is "small").

Equations (2.27), (2.28), (2.30) and (2.31) above imply that $\xi(k)$ may be approximated, as follows:

$$\xi(k) \sim F(k-1)e(k-1)$$
 (2.33)

and this, with (2.32) above implies that

$$\xi(k)$$
 is "small", (2.34)

a result important to the design of the SDP described next.

Scan Data Processor

Let γ denote the parameter vector comprising the subset of N $_G$ state variables on which u $_j$, (2.1), is functionally dependent. The general relation

$$\gamma = Hx \tag{2.35}$$

then defines a masking matrix H, $N_G \times N_S$, having rank $N_G \leq N_S$ and consisting appropriately of 1's and 0's. Other N_G -vector quantities of interest are obtained, as follows:

Extrapolated Prior Est:
$$\hat{\gamma}(k|k-1) = H\hat{x}(k|k-1)$$
 (2.36)

Error in
$$\hat{y}(k|k-1)$$
: $\epsilon(k) = H\xi(k)$ (2.37)

By (2.34), $\epsilon(k)$ in (2.37) is "small", and Murphy's Locally Optimum Estimation (LOE) theory, [9], was brought to bear on the calculation of an estimate which, around $\epsilon=0$, should be optimal in an intuitively appealing sense. The LOE criterion is summarized, in the notation of the SDP, as follows:

Locally Optimum Estimation: The estimate $\hat{\epsilon}$ of the error ϵ (in the present estimate $\hat{\gamma}$ of the parameter γ) is <u>locally optimum</u> at the point ϵ =0, if and only if (iff) the following two conditions are satisfied:

1) $\hat{\epsilon}$ is a <u>locally unbiased</u> estimate of ϵ at the point of ϵ =0, and

2) $\hat{\epsilon}$ is a <u>locally minimum mean-squared error</u> (MMSE) estimate of ϵ at the point ϵ =0,

where 'locally unbiased' and 'locally MMSE' estimations are defined as follows:

Locally Unbiased Estimation: Defining the error in the estimate $\hat{\epsilon}$ of the quantity ϵ as follows:

$$\eta(k) \stackrel{\triangle}{=} \hat{\epsilon}(k|k) - \epsilon(k) \tag{2.38}$$

and then defining the bias of the estimate $\hat{\epsilon}$ of the error ϵ (in the estimate $\hat{\gamma}$ of the parameter γ), as follows:

$$b(\varepsilon) \stackrel{\triangle}{=} \langle \eta(k) | \gamma - \hat{\gamma} = \varepsilon \rangle \tag{2.39}$$

then the estimate $\hat{\epsilon}$ of the error ϵ (in the estimate $\hat{\gamma}$ of the parameter γ) is <u>locally unbiased</u> at the point ϵ =0 iff the following two conditions are satisfied:

1)
$$b(0) = 0$$
, on N_{G} -vector (2.40a)

2)
$$\left[\frac{db(\epsilon)}{d\epsilon}\right]_{\epsilon=0} = 0$$
, on $N_G \times N_G$ matrix (2.40b)

and

Locally MMSE Estimation: Defining the mean-squared error of $\hat{\epsilon}$ in terms of η , (2.38) above, as follows:

$$\sum_{\hat{\epsilon}} (\epsilon) \stackrel{\triangle}{=} \langle \eta(k) \eta^{T}(k) \mid \gamma - \hat{\gamma} = \epsilon \rangle, ()^{T} = transpose, (2.41)$$

then the estimate $\hat{\epsilon}$ of the error ϵ (in the estimate $\hat{\gamma}$ of the parameter γ) is <u>locally MMSE</u> at the point ϵ =0 iff, for any estimate, $\hat{\delta}$, if ϵ locally unbiased at ϵ =0, the mean-squared errors of $\hat{\epsilon}$ and $\hat{\delta}$ satisfy, in the usual non-negative definite sense,

$$\Sigma_{\hat{\delta}}(0) \geq \Sigma_{\hat{\epsilon}}(0), \quad N_{\hat{G}} \times N_{\hat{G}} \text{ matrices}$$
 (2.42)

The error $\eta(k)$ is induced by the noise n(k) which is white (recall (2.11) and (2.19)); hence, clearly, local to the point $\epsilon=0$, when $\langle n \rangle=0$ via (2.39), it is true also that $\eta(k)$ is white, i.e.

$$\langle \eta(j)\eta^{T}(k)\rangle = 0, \quad j \neq k$$
 (2.43)

We take note, in passing, of the important and beneficial property given in (2.40b), requiring that errors made in estimating the various components of the vector ε be decoupled when ε =0. In addition to making the estimate unique, this is probably effective in extending the properties in (2.40a) and (2.42) into the open region around the point ε =0.

Murphy has meticulously expounded the theory and solution of the locally optimum estimation problem in his scholarly work [9] and illustrated his results in diverse examples in communications. The solution, applied to the SDP design problem at hand, involves, first, the definition of several additional quantities:

- 1. The noiseless quadratic envelope vector \mathbf{q} with element $\mathbf{q}_{\mathbf{i}}$.
- 2. The <u>linear</u> envelope vectors m and v (and associated elements), corresponding respectively to quadratic envelopes q and u.
- 3. The conditional probability density function (pdf) p(v|m)
- 4. The likelihood ration $\lambda(u|\gamma)$ Let m_{c_j} and m_{g_j} respectively be the <u>linear</u> envelope functions associated with a cosine and sine orthogonal decomposition of the noiseless i-f (or r-f) signal:

$$m_{c_{j}} = \alpha p[\theta - \theta_{A}(\tau_{j})] + \alpha_{R} p[\theta_{R} - \theta_{A}(\tau_{j})] \cos \beta_{j}... \qquad (2.44a)$$

$$m_{s_{j}} = \alpha_{R} p[\theta - \theta_{A}(\tau_{j}) \sin \beta_{j}$$
 (2.44b)

various parameters of which are as defined, following (2.1). Then, in the same manner that the J-vector u of observations u, was constructed, a noiseless quadratic envelope vector q is defined with elements q_j , $j=1,2,\ldots,J$, where

$$q_{j} = m_{c_{j}}^{2} + m_{s_{j}}^{2}$$
 (2.45)

$$= \alpha^2 p_j^2(\theta) + 2\alpha \alpha_R p_j(\theta) p_j(\theta_R) \cos \beta_j + \alpha_R^2 p_j^2(\theta_R)$$
 (2.46)

in which $p_j(\theta)$ is short-hand for $p[\theta-\theta_A(\tau_j)]$, and similarly for $p_j(\theta_R)$. The observations sample u_j , (2.1) may then be written as

$$u_{j} = (m_{c_{j}} + n_{c_{j}})^{2} + (m_{s_{j}} + n_{s_{j}})^{2}$$
(2.47)

or, equivalently

$$u_{j} = q_{j} + 2n_{c_{j}} [q_{j}]^{\frac{1}{2}} + n_{c_{j}}^{2} + n_{s_{j}}^{2}$$
(2.48)

Now, let m and v respectively represent noiseless and noisey $\underline{\text{linear}}$ envelope vectors with elements m_j and v_j, respectively, for j=1,2,...,J, where

$$m_{j} \stackrel{\triangle}{=} q_{j}^{\frac{1}{2}} = \left[m_{c}^{2} + m_{s}^{2}\right]^{\frac{1}{2}} \tag{2.49}$$

$$v_{j} \stackrel{\triangle}{=} u_{j}^{\frac{1}{2}} = \left[(m_{c_{j}} + n_{c_{j}})^{2} + (m_{s_{j}} + n_{s_{j}})^{2} \right]^{\frac{1}{2}}$$
 (2.50)

Since the sampling rate within the scan equals the i-f bandwidth, the noise samples are all nearly independent (and zero mean, Gaussian with variance 0.5; recall (2.11)). Hence, referring to [10, eq. (8-115)] for the conditional pdf $p(v_j \mid m_j)$, the conditional pdf $p(v \mid m)$ can be written

$$p(\mathbf{v}|\mathbf{m}) = \prod_{j=1}^{J} p(\mathbf{v}_{j}|\mathbf{m}_{j})$$
(2.51)

$$= 2^{J} \prod_{j=1}^{J} v_{j} I_{o}(2m_{j}v_{j}) \exp(-m_{j}^{2} - v_{j}^{2})$$
 (2.52)

where $I_0(\cdot)$ is the modified Bessel function of the first kind, zeroth order. The likelihood ratio of interest is the following:

$$\lambda = \frac{p(v|m)}{p(v|0)} = \prod_{j=1}^{J} I_o(2m_j v_j) \exp(-m_j^2)$$
 (2.53)

or, defining a new function $M_o(\cdot)$: $R^+ \to R^+$, as follows, in relation to the even function $I_o(\cdot)$ ([3], p. 13):

$$M_0(x^2) = I_0(x), x \in \mathbb{R}^1$$
 (2.54)

then, in terms of q_{j} and u_{j} , we may write

$$\lambda(\mathbf{u}|\gamma) = \prod_{j=1}^{J} M_0(4q_j \mathbf{u}_j) \exp(-q_j)$$
 (2.55)

$$= \prod_{j=1}^{J} \lambda_{j} (u_{j} | q_{j})$$
 (2.56)

where the conditioning variable on the <u>left</u> is shown as γ , rather than $q(=q(\gamma))$, to emphasize the parameter values.

The theory provides, further, that if one of the parameters upon which q is dependent is, in fact, a random variable, say ζ , in which there is no estimation interest, then it is to be averaged out before proceeding, i.e. the average likelihood ratio

$$\lambda(\mathbf{u}[\gamma) = \langle \prod_{j=1}^{J} \lambda_{j}(\mathbf{u}_{j} | \mathbf{q}_{j}(\gamma, \xi)) | \mathbf{u}, \gamma \rangle$$
 (2.57)

is used in the work below. In this approach (which formed the basis of one variant of MLS receiver design studied) clearly the noiseless envelope vector q has no further significance.

The Scan Data Processor design by the LOE approach can now be completed. In the notation of the SDP design problem (but otherwise quite generally) the estimate $\hat{\epsilon}(k|k)$ of the error $\epsilon(k)$ (in the estimate

 $\boldsymbol{\hat{\gamma}}(\boldsymbol{k} \! \mid \! k \! - \! 1)$ of the parameter vector $\boldsymbol{\gamma})$ which is locally optimum at $\epsilon \! = \! 0$ is given by

$$\hat{\varepsilon}(\mathbf{k}|\mathbf{k}) = \Phi^{-1}(\hat{\gamma}) \wedge (\mathbf{u}|\hat{\gamma})$$
 (2.58)

where, recognizing $u(k) = u(\gamma(k), n(k))$,

$$\Phi(\hat{\gamma}) \stackrel{\Delta}{=} \langle \Lambda(u(\gamma, n) | \hat{\gamma}) \Lambda^{T}(u(\gamma, n) | \hat{\gamma}) | \gamma = \hat{\gamma} \rangle$$
 (2.59)

denoted as the LOE (Fisher) Information Matrix, and

$$\Lambda(\mathbf{u} \mid \hat{\mathbf{y}}) \stackrel{\Delta}{=} \begin{cases} \frac{\partial}{\partial \hat{\mathbf{y}}} & \ln \lambda(\mathbf{u} \mid \hat{\mathbf{y}}) & \lambda(\mathbf{u} \mid \hat{\mathbf{y}}) \neq 0 \\ 0, & \text{otherwise} \end{cases}$$
 (2.60)

Further, the mean-squared error, Σ , (2.41), of this estimate local to the point $\epsilon=0$ is

$$\Sigma(o) = \Phi^{-1}(\gamma) \tag{2.61}$$

As indicated above, several variants to the basic MLS receiver design using this approach were studied, differing initially in their definitions of the state and/or parameter vectors, x and γ respectively. Detailed development of the LOE quantities defined above is deferred until the next section of this chapter where the various designs specific to particular state and/or parameter vector formulations will be described. We conclude this discussion of the Scan Data Processor by noting that, in view of (2.58) and (2.61) above, the principle calculations done by the SDP are those of $\Phi(\hat{\gamma})$ and $\Lambda(u|\hat{\gamma})$. These, in fact, are the quantities passed to the Tracking Loop Filter, discussed next.

Tracking Loop Filter

Inputs to the Tracking Loop Filter from the Scan Data Processor are the quantities $\Lambda(u \mid \hat{\gamma}(k \mid k-1))$ and $\Phi(\hat{\gamma}(k \mid k-1))$. If we form the estimate

 $\boldsymbol{\hat{\epsilon}}(\boldsymbol{k} \, \big| \, \boldsymbol{k}) \,,$ as prescribed in (2.58), that is:

$$\hat{\varepsilon}(\mathbf{k}|\mathbf{k}) = R(\hat{\gamma}) \wedge (\mathbf{u}|\hat{\gamma}) \tag{2.62}$$

where
$$\hat{y} = \hat{y}(k|k-1)$$
 (2.63)

and
$$R(\hat{y}) \stackrel{\Delta}{=} \phi^{-1}(\hat{y}(k|k-1))$$
 (2.64)

and then tentatively form a "pre-estimate", $\hat{\gamma}(k \mid k)$, in the following manner:

$$\hat{\hat{\mathbf{y}}}(\mathbf{k}|\mathbf{k}) = \hat{\mathbf{y}}(\mathbf{k}|\mathbf{k}-1) + \hat{\boldsymbol{\epsilon}}(\mathbf{k}|\mathbf{k}), \qquad (2.65)$$

we find that $\hat{\gamma}$ can be written

$$\hat{\hat{y}} = \hat{y}(k|k-1) + \varepsilon(k) + \hat{\varepsilon}(k|k) - \varepsilon(k)$$
 (2.66)

$$= \gamma(k) + \eta(k) \tag{2.67}$$

$$= Hx(k) + \eta(k) \tag{2.68}$$

i.e. the pre-estimate $\hat{\gamma}(k|k)$, in a neighborhood of $\epsilon=0$, is in fact, a "pseudo-observation" which is both <u>linear</u> in x and corrupted <u>additively</u> by the zero mean, white noise $\eta(k)$ with covariance $R(\hat{\gamma}(k|k-1))$, (2.63).

Following conventional Kalman filter theory and forming the innovations process, $\hat{\gamma}(k|k-1) - \hat{\hat{\gamma}}(k|k)$, gives

$$\hat{\gamma}(k|k-1) - \hat{\hat{\gamma}}(k|k) = \hat{\epsilon}(k|k)$$
 (2.69)

i.e. the innovations process is the estimate $\hat{\epsilon}(k|k)$, (2.62), produced (effectively) by the LOE-theory-based Scan Data Processor. The filter state update equation has the form

$$\hat{\mathbf{x}}(\mathbf{k}|\mathbf{k}) = \hat{\mathbf{x}}(\mathbf{k}|\mathbf{k}-1) + \kappa(\mathbf{k})\hat{\boldsymbol{\varepsilon}}(\mathbf{k}|\mathbf{k})$$
 (2.70)

where K(k), the Kalman gain, is calculated by cycling through 3 equations for each value of k, k = 1, 2, ..., usually as follows:

Extrapolated Error Covariance:

$$P(k | k-1) = F(k-1)P(k-1 | k-1)F^{T}(k-1) + G(k-1)Q(k-1)G^{T}(k-1)$$
 (2.71)

Kalman Gain:

$$\kappa(k) = P(k|k-1)H^{T}[HP(k|k-1)H^{T} + R(\hat{\gamma})]^{-1}$$
 (2.72)

Updated Error Covariance:

$$P(k|k) = (I-\kappa(k)H)P(k|k-1)(I-\kappa(k)H)^{T} + \kappa(k)R\hat{y})\kappa^{T}(k)$$
(2.73)

In the present application some simplification is possible, however. Comparing (2.26) and (2.70) above indicates that

$$\xi(\mathbf{k}|\mathbf{k}) = \kappa(\mathbf{k})\hat{\epsilon}(\mathbf{k}|\mathbf{k}) \tag{2.74}$$

$$= \kappa(k)R(\hat{y})\Lambda(u|\hat{y}) \tag{2.75}$$

and substituting from (2.72) into the latter gives

$$\xi(k|k) = P(k|k-1)H^{T}[HP(k|k-1)H^{T} + R(\hat{\gamma})]^{-1}R(\hat{\gamma})\wedge(u|\hat{\gamma})$$
 (2.76)

or, after simplifying,

$$\hat{\xi}(k|k) = \Gamma(k)\Lambda(u|\hat{\gamma}) \tag{2.77}$$

where

$$\Gamma(k) = P(k | k-1)H^{T}[I + \Phi(\hat{y})HP(k | k-1)H^{T}]^{-1}$$
 (2.78)

is a new N_S x N_G gain matrix not requiring the inversion of the matrix $\Phi(\hat{\gamma})$ (produced by the SDP) for its calculation (by (2.64), R⁻¹($\hat{\gamma}$) appearing in the simplification, was replaced by $\Phi(\hat{\gamma})$). The refined state-estimate update equation, corresponding to (2.70) is the following:

$$\hat{\mathbf{x}}(\mathbf{k}|\mathbf{k}) = \hat{\mathbf{x}}(\mathbf{k}|\mathbf{k}-1) + \Gamma(\mathbf{k})\Lambda(\mathbf{u}|\hat{\mathbf{y}})$$
 (2.79)

Comparing (2.75) and (2.77) indicates that

$$\kappa(k)R(\hat{\gamma}) = \Gamma(k) \tag{2.80}$$

or that

$$\kappa(k) = \Gamma(k)R^{-1}(\hat{\gamma}) = \Gamma(k)\phi(\hat{\gamma}) \tag{2.81}$$

Substituting this into (2.73) and simplifying gives the following:

Updated Error Covariance:

 $P(k \mid k) = (I - \Gamma(k) \Phi(\hat{\gamma}) H) P(k \mid k-1) (I - \Gamma(k) \Phi(\hat{\gamma}) H)^{T} + \Gamma(k) \Phi(\hat{\gamma}) \Gamma^{T}(k) \quad (2.82)$ which also does not require the inversion of $\Phi(\gamma)$.

In summary, the MLS receiver design developed, a tracking receiver, will operate as a recursive state estimator and begin the (kth) data processing cycle by extrapolating the prior state estimate $\hat{x}(k-1|k-1)$ to the present, producing the

Extrapolated State Estimate, $\hat{x}(k|k-1)$, (2.27) and then masking it, giving the

Extrapolated Parameter Estimate, $\hat{\gamma}(k|k-1)$, (2.36)

this, an estimate of parameter vector $\gamma(k)$ with error $\epsilon(k)$. Next, given $\hat{\gamma}(k \mid k-1)$ and the vector u(k) of observations, the Scan Data Processor, designed under a criterion of producing an estimate $\hat{\epsilon}(k \mid k)$ of error $\epsilon(k)$ that is <u>locally optimum</u> at $\epsilon=0$, stops short of this result and instead calculates the following:

Log Likelihood Ratio, $\Lambda(u|\hat{y})$, (2.60)

LOE Information Matrix, $\Phi(\hat{\gamma})$, (2.59)

The Tracking Loop Filter accepts Λ and Φ from the SDP and completes the data processing cycle with following sequence of calculations.

Extrapolated Error Covariance, P(k|k-1), (2.71)

Filter Gain, $\Gamma(k)$, (2.78)

Updated State Estimate, $\hat{x}(k|k)$, (2.79)

Updated Error Covariance, P(k|k), (2.82).

This concludes the derivation at the general level. The results are specialized to particular state- and parameter-vector formulations next.

D. SPECIFIC DESIGNS

Throughout the research program three specializations of the above general design structure received most of the attention. These are characterized by the formulations of their parameter and state <u>estimate</u> vectors, as follows:

i. "Non-adaptive" Design

$$N_G = 2, \quad \hat{\gamma} = (\hat{\alpha}, \hat{\theta})^T$$
 (2.83)

$$N_s = 3, \quad \hat{x} = (\hat{\alpha}, \hat{\theta}, \hat{\dot{\theta}})^T$$
 (2.84)

ii. "Optimal" Design (Adaptive)

$$N_G = 5, \quad \hat{\gamma} = (\hat{\alpha}, \hat{\theta}, \hat{\alpha}_R, \hat{\theta}_R, \hat{\beta})^T$$
 (2.85)

$$N_s = 8$$
, $\hat{x} = (\hat{\alpha}, \hat{\theta}, \hat{\theta}, \hat{\alpha}_R, \hat{\theta}_R, \hat{\theta}_R, \hat{\beta}, \hat{\omega}_{sc})^T$ (2.86)

iii. "Suboptimal" Design (Adaptive)

$$N_G = 4, \quad \hat{\gamma} = (\hat{\alpha}, \hat{\theta}, \hat{\alpha}_R, \hat{\theta}_R)^T$$
 (2.87)

$$N = 6, \quad \hat{x} = (\hat{\alpha}, \hat{\theta}, \hat{\theta}, \hat{\alpha}, \hat{\theta}, \hat{\theta})^{T} \qquad (2.88)$$

The non-adaptive design was identified and studied as a baseline design in accessing the benefits of adaptivity as supplied by the other designs. The optimal design was the principal focus of the study; the definitions (2.85) and (2.86), and the resulting design, are predicated on the assumption that the multipath interference phenomenon, when present (in q, (2.46), e.g.), is one which is fully described by samples taken at the angle function repetition rate, or more concisely, via the sampling theorem,

$$w_{sc} < \pi(\text{Rep. Rate}) = \frac{\pi}{T}$$
 (2.89)

where T is the interval between scans. Under this assumption then, β on the active scan is nearly constant, i.e. in q, (2.46),

$$\beta_{j} \approx \beta(k)$$
, for all $j = 1, 2, ---, J$ (2.90)

(where $\beta(k)$ is the phase difference at the start of the kth scan) and hence \hat{w}_{SC} does not appear in the \hat{y} -formulation for this design. The relation (2.89) is a restriction that would not always be met in practice, of course, and the suboptimal design represented an effort to formally relax this condition and simultaneously reduce the dimensions of the vectors and hence the complexity of the algorithm. This design was accomplished by

- i. Assuming the β_j in q (2.46) were all independent random variables, uniformly distributed on the interval $(-\pi,\pi)$ (corresponding to the assumption that $\omega_{SC} \rightarrow \infty$); then
- ii. Following (2.57) and taking the average of the likelihood ratio over all the β_j and then using it in the subsequent design.

Both the state and parameter vectors are devoid of both β and w in this third design.

A fourth and very recently conceived design, motivated also by the desire to relax the restriction (2.89), though more complex than the "Optimal" design, is characterized as follows:

"6D LOE" Design (adaptive)

$$N_G = 6, \quad \hat{\gamma} = (\hat{\alpha}, \hat{\theta}, \hat{\alpha}_R, \hat{\theta}_R, \hat{\beta}, \hat{\omega}_{sc})^T$$
 (2.91)

and

$$N_s = 8, \quad \hat{x} = (\hat{\alpha}, \hat{\theta}, \hat{\theta}, \hat{\hat{\theta}}, \hat{\alpha}_R, \hat{\theta}_R, \hat{\theta}_R, \hat{\beta}, \hat{\omega}_{sc})^T$$
 (2.92)

or

$$N_s = 9$$
, $\hat{x} = (\hat{\alpha}, \hat{\theta}, \hat{\theta}, \hat{\alpha}_R, \hat{\theta}_R, \hat{\theta}_R, \hat{\beta}, \hat{\omega}_{SC}, \hat{\omega}_{SC})^T$ (2.93)

The assumption here is that there is sufficient information in the J

samples taken within a <u>single</u> scan (J/2 on each semi-scan, centered on the expected centroid of the direct path pulse) to produce an estimate of \mathbf{w}_{sc} using just one scan's data; it appears also the fractional accuracy of such an estimate would improve with increasing \mathbf{w}_{sc} , though it may be somewhat θ -dependent, since the interval between the TO-s'can and FRO-scan pulses' is both θ -dependent and relevant to the \mathbf{w}_{sc} -estimate produced (or, more specifically, the LOE estimate of the error in $\hat{\mathbf{w}}_{sc}(\mathbf{k}\,|\,\mathbf{k}$ -1). The "6D LOE" design will be described in Appendix C with any results obtained at the time of grant closure.

Here we focus on the earlier designs, in particular, the details for the optimal and suboptimal designs. The non-adaptive design is clearly imbedded, in a sense, in both of these designs and needn't be treated separately.

Optimal Design

For this case, referencing (2.56), $\lambda(u\mid \hat{\gamma})$ can be written as follows:

$$\lambda(\mathbf{u}|\hat{\mathbf{y}}) = \prod_{j=1}^{J} \lambda_{j} (\mathbf{u}_{j}|\hat{\mathbf{q}}_{j})$$
 (2.94)

where

$$\lambda_{j}(\mathbf{u}_{j} | \hat{\mathbf{q}}_{j}) \stackrel{\Delta}{=} M_{o}(4\hat{\mathbf{q}}_{j}\mathbf{u}_{j}) \exp(-\hat{\mathbf{q}}_{j})$$
(2.95)

$$>$$
 0, for all u_{i} and finite \hat{q}_{i} (2.96)

and

$$\hat{\mathbf{q}}_{\mathbf{j}} \stackrel{\Delta}{=} \mathbf{q}_{\mathbf{j}}(\hat{\mathbf{y}}) \tag{2.97}$$

$$= \hat{\alpha}^2 p^2_{j} (\hat{\theta}) + 2\hat{\alpha}\hat{\alpha}_{R} p_{j} (\hat{\theta}) p_{j} (\hat{\theta}_{R}) \cos \hat{\beta} + \hat{\alpha}_{R}^2 p_{j}^2 (\hat{\theta}_{R})$$
 (2.98)

Hence, via (2.60)

$$\Lambda(\mathbf{u}|\hat{\gamma}) \stackrel{\Delta}{=} \frac{\partial \ln}{\partial \hat{\gamma}} \lambda(\mathbf{u}|\hat{\gamma}) = \sum_{j=1}^{J} \Lambda_{j} (\mathbf{u}_{j}|\hat{q}_{j})$$
 (2.99)

where

$$\wedge_{\mathbf{j}}(\mathbf{u}_{\mathbf{j}}|\hat{\mathbf{q}}_{\mathbf{j}}) \stackrel{\Delta}{=} \frac{\partial}{\partial \hat{\gamma}} \ln \lambda_{\mathbf{j}}(\mathbf{u}_{\mathbf{j}}|\hat{\mathbf{q}}_{\mathbf{j}}) = \frac{\frac{\partial \lambda_{\mathbf{j}}}{\partial \hat{\gamma}} (\mathbf{u}_{\mathbf{j}}|\hat{\mathbf{q}}_{\mathbf{j}})}{\lambda_{\mathbf{j}}(\mathbf{u}_{\mathbf{j}}|\hat{\mathbf{q}}_{\mathbf{j}})}$$

$$= \frac{d\hat{q}_{j}}{d\hat{\gamma}} \frac{\frac{\partial \lambda_{j}}{\partial \hat{q}_{j}} (u_{j} | \hat{q}_{j})}{\lambda_{j} (u_{j} | \hat{q}_{j})}$$
(2.100)

or

$$\Lambda(\mathbf{u}|\hat{\gamma}) = D(\hat{\gamma})\mathbf{w}(\mathbf{u}|\mathbf{q}(\hat{\gamma})) \tag{2.101}$$

in which

$$D(\hat{\gamma}) \stackrel{\triangle}{=} \frac{d\hat{q}}{d\hat{\gamma}} = \begin{pmatrix} \frac{\partial \hat{q}_{1}(\hat{\gamma})}{\partial \hat{\gamma}_{1}} & \cdots & \frac{\partial \hat{q}_{J}(\hat{\gamma})}{\partial \hat{\gamma}_{1}} \\ \frac{\partial \hat{q}_{1}}{\partial \hat{\gamma}_{N_{G}}} & \cdots & \frac{\partial \hat{q}_{J}(\hat{\gamma})}{\partial \hat{\gamma}_{N_{G}}} \end{pmatrix}, N_{G} \times J \qquad (2.102)$$

$$\begin{pmatrix} --- 2\hat{\alpha}p_{j}^{2}(\hat{\theta}) + 2\hat{\alpha}_{R}p_{j}(\hat{\theta})p_{j}(\hat{\theta}_{R})\cos\hat{\beta} --- \\ --- 2\hat{\alpha}^{2}p_{j}(\hat{\theta})\dot{p}_{j}(\hat{\theta}) + 2\hat{\alpha}\hat{\alpha}_{R}\dot{p}_{j}(\hat{\theta})p_{j}(\hat{\theta}_{R})\cos\hat{\beta} --- \\ --- 2\hat{\alpha}p_{j}(\hat{\theta})p_{j}(\hat{\theta}_{R})\cos\hat{\beta} + 2\hat{\alpha}_{R}p_{j}^{2}(\hat{\theta}_{R}) --- \\ --- 2\hat{\alpha}\hat{\alpha}_{R}p_{j}(\hat{\theta})\dot{p}_{j}(\hat{\theta}_{R})\cos\hat{\beta} + 2\hat{\alpha}_{R}^{2}\dot{p}_{j}(\hat{\theta}_{R})p_{j}(\hat{\theta}_{R}) --- \\ --- (-2\hat{\alpha}\hat{\alpha}_{R}p_{j}(\hat{\theta})p_{j}(\hat{\theta}_{R})\sin\hat{\beta}) --- \end{pmatrix} (2.103)$$

where

$$\dot{p}_{j}(\theta) \stackrel{\Delta}{=} \frac{d}{d\theta_{e}} p[\theta_{e}] \Big|_{\theta_{e} = \theta - \theta_{A}(\tau_{j})}$$
 (and similarly for $\dot{p}_{j}(\theta_{R})$), (2.104)

and

$$w(u|\hat{\gamma}) \stackrel{\triangle}{=} (---, w_j(u_j|\hat{\gamma}), ---)^T, J-vector$$
 (2.105)

where

$$\mathbf{w}_{\mathbf{j}}(\mathbf{u}_{\mathbf{j}}|\hat{\gamma}) \triangleq \frac{\frac{\partial \lambda_{\mathbf{j}}}{\partial \hat{\mathbf{q}}_{\mathbf{j}}} (\mathbf{u}_{\mathbf{j}}|\hat{\mathbf{q}}_{\mathbf{j}})}{\lambda_{\mathbf{j}}(\mathbf{u}_{\mathbf{j}}|\hat{\mathbf{q}}_{\mathbf{j}})}$$
(2.106)

$$= 4u_{j} \frac{M_{1}}{M_{0}} (4q_{j}(\hat{y})u_{j}) - 1$$
 (2.107)

in which
$$\frac{\frac{M_1}{M_0}}{\left(\cdot\right)} \stackrel{\triangle}{=} \frac{\frac{M_1(\cdot)}{M_0(\cdot)}}{\left(2.108\right)}$$
(2.108)

and, for any real z>0,

$$M_{1}(z) \stackrel{\triangle}{=} \frac{d}{dz} M_{0}(z)$$
 (2.109)

where $M_0(\cdot)$ was as defined in (2.54) in relation to $I_0(\cdot)$, as follows for any real x:

$$M_0(x^2) = I_0(x)$$
 (2.110)

A corresponding relation for M_1 () is as follows:

$$M_{1}(x^{2}) = \frac{1}{2x} I_{1}(x) \tag{2.111}$$

where $I_1(\cdot)$ is the modified Bessel function of the first kind, first order. The well-known soft-limiter characteristic of

$$\frac{I_1}{I_0}$$
 (*) (initial slope of $\frac{1}{2}$, saturation value of 1)

corresponds to the following for $\frac{n_1}{M}$ (x), x \geq 0:

$$\frac{M_1}{M_0}$$
 (x) $= \frac{1}{4}$ (2.112)

$$\frac{d}{dx} \frac{M_1}{M_0} (x) \bigg|_{x=0} = -\frac{1}{32}$$
 (2.113)

These conditions are satisfied exactly by the approximation ([3], pp. 15-17)

$$\frac{M_{1}}{M_{0}} (x) = \frac{1}{2 (4+x)^{\frac{1}{2}}}$$
 (2.115)

whose error peaks at only 4% around x=30. Substituting this in (2.107) above for $w_j(u_j|\hat{\gamma})$ gives the expression

$$w_{j}(u_{j}|\hat{\gamma}) \approx \frac{u_{j}}{(1 + q_{j}(\hat{\gamma})u_{j})^{\frac{1}{2}}} - 1$$
 (2.116)

which was used in this design.

Substituting (2.101) above in the defining equation (2.59) for the LOE Information Matrix $\boldsymbol{\Phi}$ gives

$$\Phi(\hat{\mathbf{y}}) \stackrel{\Delta}{=} \langle \Lambda(\mathbf{u}(\mathbf{y}, \mathbf{n}) | \hat{\mathbf{y}}) \Lambda^{\mathrm{T}}(\mathbf{u}(\mathbf{y}, \mathbf{n}) | \hat{\mathbf{y}}) | \mathbf{y} = \hat{\mathbf{y}} \rangle$$
 (2.117)

$$= D(\hat{\gamma})H_{W}(q(\hat{\gamma}))D^{T}(\hat{\gamma})$$
 (2.118)

where

$$\mathbb{H}_{\mathbf{W}}(\mathbf{q}(\hat{\mathbf{y}})) \stackrel{\Delta}{=} \langle \mathbf{w}(\mathbf{u}(\mathbf{y}, \mathbf{n}) | \hat{\mathbf{y}}) \mathbf{w}^{\mathrm{T}}(\mathbf{u}(\mathbf{y}, \mathbf{n}) | \hat{\mathbf{y}}) | \mathbf{y} = \hat{\mathbf{y}}) \rangle$$
 (2.119)

The criterion for locally optimum estimation (more specifically, locally unbiased estimation) at $\epsilon=0$ assures that

$$0 = \langle \Lambda(u(\gamma, n) | \hat{\gamma}) | \gamma = \hat{\gamma} \rangle = D(\hat{\gamma}) \langle w(u(\gamma, n) | \hat{\gamma}) | \gamma = \hat{\gamma} \rangle$$
 (2.120)

A simulation study ([4], p.15) of the process $w(u \mid \hat{\gamma})$, using the approximation (2.116) gave support for (2.120) as well as strong evidence that $w(u \mid \hat{q})$ is white, i.e.

$$\langle w_{\mathbf{i}}(u_{\mathbf{i}}(\gamma, n_{\mathbf{i}}) | \hat{\gamma}) w_{\mathbf{j}}(u_{\mathbf{j}}(\gamma, n_{\mathbf{j}}) | \hat{\gamma}) | \gamma = \hat{\gamma} \rangle = \begin{cases} 0, & \text{for } i \neq j \\ h_{w_{\mathbf{j}}}(\hat{\gamma}), & \text{for } i = j \end{cases} (2.121)$$

and on this basis $H_W(\hat{q})$, (2.119), which is the covariance of $w(u|\hat{q})$ local to $\gamma-\hat{\gamma}=0$, was taken as diagonal, i.e.

$$H_{W}(\hat{q}) = Diag(..., h_{W_{j}}(\hat{y}), ...), J \times J$$
 (2.122)

where $h_{\hat{W}}$ (\hat{y}), it was also found ([4], Appendix A), could be approximated, as follows:

$$h_{w_{j}}^{j}(\hat{\gamma}) \approx \frac{1}{1+2 q_{j}(\hat{\gamma})}$$
(2.123)

with an error that peaked at about 20% for $\hat{q}_i = 2$.

The antenna scanning function, $\theta_A(\tau)$, used was the following

$$\theta_{A}(\tau_{j}) \triangleq \begin{cases} \theta_{A_{max}} + \Omega \tau_{j} &, & 0 \le \tau_{j} \le T_{s} \\ \theta_{A_{min}} &, & T_{s} \le \tau_{j} \le T_{F} \\ \theta_{A_{min}} - \Omega(\tau_{j} - T_{F}), & T_{F} \le \tau_{j} \le T_{1} \end{cases}$$

$$(2.124)$$

where the parameters are defined, as follows: (see Figure 2.1)

$$\Omega \stackrel{\triangle}{=} - \frac{\theta_{\text{Max}} - \theta_{\text{Min}}}{T_{\text{s}}}$$
 (2.125)

$$T_{F} \stackrel{\triangle}{=} T_{S} + T_{R} - 2 \frac{\theta_{A}}{\Omega}$$
 (2.126)

$$T_s \stackrel{\triangle}{=} duration of the TO-scan$$
 (2.127)

$$T_{R} \stackrel{\triangle}{=} interval between zero intercepts$$
 (2.128)

$$T_{1} \stackrel{\triangle}{=} T_{S} + T_{F} \tag{2.129}$$

Values for the parameters θ_{Amax} , θ_{Amin} , T_s and T_R are essentially prescribed by the MLS specifications and will be given in the simulation

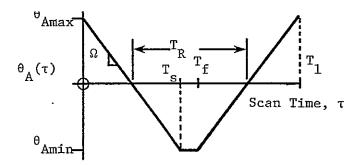


Figure 2.1 MLS Antenna Scanning Function

discussion. The antenna selectivity function, $p(\)$, and its derivative $\dot{p}(\)$, are not prescribed in the specifications; plausible functions were chosen for simulation use, however, and these will be described later, also. This completes the description of the scan data processor for the optimal design.

The $\hat{\gamma}$ and \hat{x} vector formulations in (2.85) and (2.86) require matrices F and H in the tracking loop, as follows:

$$F = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & T & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & T & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & T \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \end{pmatrix}$$
 (2.131)

The product matrix GQG^T used was a diagonal one in which the diagonal elements represented generally measures (variances) of the intuitive uncertainty in the elements of x(k), given those of x(k-1). The following values were selected as part of the tracking loop design:

$$GQG_{11}^{T} = GQG_{44}^{T} = Max \{(\frac{1}{2})^{2}, (\frac{\hat{y}}{10})^{2}\}$$
 (2.132)

representing 10% uncertainty for $S/N \ge 14$ db (in the direct path signal strength only; the assignment of the same value to the '44' component was arbitrary);

$$GQG_{22}^{T} = GQG_{55}^{T} = GQG_{77}^{T} = 0 (2.133)$$

representing full reliance in these coordinates on integrations of derivatives;

$$GQG_{33}^{T} = GQG_{66}^{T} = \begin{vmatrix} \ddot{\theta}_{max} \end{vmatrix}^{2} T \begin{vmatrix} & & & \\$$

where $\left| \stackrel{\circ}{\theta}_{\text{max}} \right| = 0.1 \text{ deg/sec}^2$ in Azimuth, was determined from a study of a representative set of landing patterns ([3], pp. 40ff);

$$GQG_{88}^{T} = (\frac{\Delta\beta}{T})^{2} = \frac{0.04}{T^{2}} (\ll(\frac{\pi}{T})^{2})$$
 (2.135)

representing an error $\Delta\beta$ in phase (due to w_{sc} uncertainty (i.e. error)) of 0.2 radians between scans, well within the limit of π radians associated with the sampling theorem.

Finally, in recognition of the limitations on the <u>true</u> values of the states, imposed by system geometry, modeling ambiguities, etc., the results obtained from the estimation algorithm described thus far were subjected to various additional constraint operations before being designated and subsequently evaluated as "the estimates". Each of these constraints are described pictorially in Figure 2.2 in the conventional format of an input—output graph of a function of one variable. In all cases the abscissa (input) is the result of the estimation update, (2.79) above, and the ordinate is the estimate to be output (or used in the next estimation cycle).

Suboptimal Design

For this case, the $\beta_j,\ j=1,2,$ ---, J, are taken as independent random variables, each uniformly distributed on $[-\pi,\pi]$. Conceptually, \hat{q}_j is also random and can be written

$$\hat{q}_{j} = \hat{q}_{A_{j}} + \hat{q}_{B_{j}} \cos \beta_{j} = q_{j}(\hat{\gamma}, \beta_{j})$$
 (2.136)

where

$$\hat{q}_{A_{j}} \stackrel{\Delta}{=} \hat{\alpha}^{2} p_{j}^{2} (\hat{\theta}) + \hat{\alpha}_{R}^{2} p_{j}^{2} (\hat{\theta}_{R}) = q_{A_{j}} (\hat{\gamma}), > 0$$
(2.137)

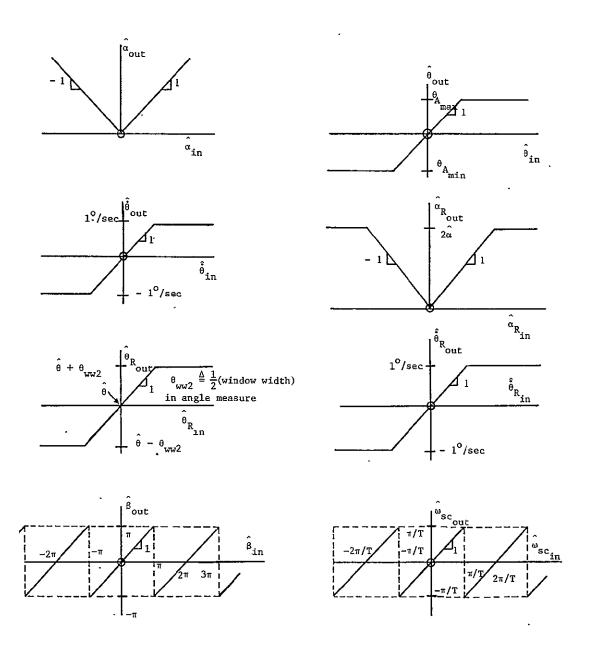


Figure 2.2 Constraints on Estimates

$$\hat{q}_{B_{j}} \stackrel{\triangle}{=} 2\hat{\alpha}\hat{\alpha}_{R}^{p}_{j}(\hat{\theta})_{p_{j}}(\hat{\theta}_{R}) = q_{B_{j}}(\hat{\gamma}), \text{ indefinite}$$
 (2.138)

and

$$-\hat{q}_{A_{j}} \leq \hat{q}_{B_{j}} \leq \hat{q}_{A_{j}}$$

$$(2.139)$$

We seek $\lambda(\mathbf{u} \mid \hat{\mathbf{y}})$, which, applying (2.57), is given by

$$\lambda(\mathbf{u} | \hat{\mathbf{y}}) = \langle \prod_{j=1}^{J} \lambda_{j} (\mathbf{u}_{j} | \mathbf{q}_{j} (\hat{\mathbf{y}}, \beta_{j})) | \mathbf{u}, \hat{\mathbf{y}} \rangle$$
(2.140)

in which the averaging is done wrt the β_j , j=1,2, ---, J. Because the β_j are independent this can be written in a form similar to (2.94) as follows:

$$\lambda(\mathbf{u}|\hat{\mathbf{y}}) = \prod_{j=1}^{J} \lambda_{j} (\mathbf{u}_{j}|\hat{\mathbf{q}}_{A_{j}}, \hat{\mathbf{q}}_{B_{j}})$$
(2.141)

where

$$\lambda_{j}(u_{j}|\hat{q}_{A_{j}}, \hat{q}_{B_{j}}) \stackrel{\triangle}{=} \langle \lambda_{j}(u_{j}|q_{j}(\hat{\gamma}, \beta_{j}))|u_{j}, \hat{\gamma} \rangle$$
 (2.142)

And, as in (2.99),

$$\Lambda(\mathbf{u} \mid \hat{\mathbf{y}}) = \sum_{j=1}^{J} \lambda_{j} (\mathbf{u}_{j} \mid \hat{\mathbf{y}})$$
 (2.144)

where, here,

$$\Lambda_{j}(\mathbf{u}_{j}|\hat{\mathbf{y}}) = \frac{\partial}{\partial \hat{\mathbf{y}}} \ln \lambda_{j}(\mathbf{u}_{j}|\hat{\mathbf{q}}_{A_{j}},\hat{\mathbf{q}}_{B_{j}})$$
 (2.145)

$$= \frac{\frac{\partial}{\partial \hat{\gamma}} \lambda_{j} (u_{j} | \hat{q}_{Aj}, \hat{q}_{Bj})}{\lambda_{j} (u_{j} | \hat{q}_{Aj}, \hat{q}_{Bj})}$$

$$(2.146)$$

$$= (\frac{d\hat{q}_{A_{j}}}{d\hat{\gamma}})(\frac{\frac{\partial}{\partial \hat{q}_{A_{j}}}\lambda(u_{j}|\hat{q}_{A_{j}},\hat{q}_{B_{j}})}{\lambda(u_{j}|\hat{q}_{A_{j}},\hat{q}_{B_{j}})} + (\frac{d\hat{q}_{B_{j}}}{d\hat{\gamma}})(\frac{\frac{\partial}{\partial \hat{q}_{B_{j}}}\lambda(u_{j}|\hat{q}_{A_{j}},\hat{q}_{B_{j}})}{\lambda(u_{j}|\hat{q}_{A_{j}},\hat{q}_{B_{j}})})$$

$$= (\frac{d\hat{q}_{A_{j}}}{d\hat{\gamma}})(\frac{1}{\lambda(u_{j}|\hat{q}_{A_{j}},\hat{q}_{B_{j}})})$$

$$(2.147)$$

Consequently, $\Lambda(\mathbf{u} \mid \hat{\mathbf{y}})$ in (2.144) above, may be written

$$\Lambda(\mathbf{u} | \hat{\mathbf{y}}) = D_{\mathbf{A}}(\hat{\mathbf{y}}) \mathbf{w}_{\mathbf{A}}(\mathbf{u} | \hat{\mathbf{y}}) + D_{\mathbf{B}}(\hat{\mathbf{y}}) \mathbf{w}_{\mathbf{B}}(\mathbf{u} | \hat{\mathbf{y}})$$
(2.148)

where

$$D_{\mathbf{A}}(\hat{\mathbf{y}}) \stackrel{\Delta}{=} \begin{pmatrix} ---\frac{\partial q_{\mathbf{A}_{\mathbf{j}}}(\hat{\mathbf{y}})}{\partial \hat{\mathbf{y}}_{\mathbf{1}}} & --- \\ -------- \\ \frac{\partial q_{\mathbf{A}_{\mathbf{j}}}(\hat{\mathbf{y}})}{\partial \hat{\mathbf{y}}_{\mathbf{N}_{\mathbf{G}}}} & --- \end{pmatrix}, N_{\mathbf{G}} \times \mathbf{J}$$

$$(2.149)$$

$$\begin{pmatrix} --- & 2\hat{\alpha}p_{j}^{2}(\hat{\theta}) & --- \\ --- & 2\hat{\alpha}^{2}p_{j}(\hat{\theta})\dot{p}_{j}(\hat{\theta}) & --- \\ --- & 2\hat{\alpha}_{R}p_{j}^{2}(\hat{\theta}_{R}) & --- \\ --- & 2\hat{\alpha}^{2}_{R}p_{j}(\hat{\theta}_{R})\dot{p}_{j}(\hat{\theta}_{R}) & --- \end{pmatrix}, \qquad (2.150)$$

$$\mathbb{D}_{\mathbf{B}}(\hat{\mathbf{y}}) \stackrel{\Delta}{=} \left(\begin{array}{cccc} & -\mathbf{0} & \mathbf{q}_{\mathbf{B}_{\hat{\mathbf{j}}}} & -\mathbf{0} & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\$$

$$\begin{pmatrix}
--- 2\hat{\alpha}_{R}^{p}_{j}(\hat{\theta}_{R}) & p_{j}(\hat{\theta}) & --- \\
--- 2\hat{\alpha}\hat{\alpha}_{R}^{p}_{j}(\hat{\theta})p_{j}(\hat{\theta}_{R}) & --- \\
--- 2\hat{\alpha}p_{j}(\hat{\theta})p_{j}(\hat{\theta}_{R}) & --- \\
--- 2\hat{\alpha}\hat{\alpha}_{R}^{p}_{j}(\hat{\theta})\dot{p}_{j}(\hat{\theta}_{R}) & --- \\
--- 2\hat{\alpha}\hat{\alpha}_{R}^{p}_{j}(\hat{\theta})\dot{p}_{j}(\hat{\theta}_{R}) & --- \\
\end{pmatrix} (2.152)$$

$$\mathbf{w}_{\mathbf{A}}(\mathbf{u}|\hat{\mathbf{y}}) \stackrel{\Delta}{=} (---\mathbf{w}_{\mathbf{A}_{\mathbf{j}}}(\mathbf{u}_{\mathbf{j}}|\hat{\mathbf{y}}) ---)^{\mathrm{T}}, \text{ J-vector}$$
(2.153)

$$\mathbf{w}_{\mathbf{B}}(\mathbf{u}|\hat{\mathbf{y}}) \stackrel{\triangle}{=} (---\mathbf{w}_{\mathbf{B}_{\hat{\mathbf{J}}}}(\mathbf{u}_{\hat{\mathbf{J}}}|\hat{\mathbf{y}})---)^{\mathrm{T}}, \text{ J-vector}$$
(2.154)

in which

$$w_{A_{j}}(u_{j}|\hat{\gamma}) \stackrel{\Delta}{=} \frac{\frac{\partial}{\partial \hat{q}_{A_{j}}} \lambda_{j}(u_{j}|\hat{q}_{A_{j}},\hat{q}_{B_{j}})}{\lambda_{j}(u_{j}|\hat{q}_{A_{j}},\hat{q}_{B_{j}})}$$

$$(2.155)$$

$$= \frac{\frac{\partial}{\partial \hat{q}_{A_{j}}} \lambda_{j} (u_{j} | q_{j}(\hat{\gamma}, \beta_{j})) | u_{j}, \hat{\gamma})}{\langle \lambda_{j} (u_{j} | q_{j}(\hat{\gamma}, \beta_{j})) | u_{j} \hat{\gamma} \rangle}$$

$$= \frac{\partial}{\partial \hat{q}_{A_{j}}} \lambda_{j} (u_{j} | q_{j}(\hat{\gamma}, \beta_{j})) | u_{j} \hat{\gamma} \rangle$$
(2.156)

$$= \frac{\langle (\frac{\partial \hat{q}_{j}}{\partial \hat{q}_{A_{j}}})(\frac{\partial \lambda_{j}}{\partial \hat{q}_{j}} (u_{j}|\hat{q}_{j})|u_{j},\hat{\gamma})\rangle}{\langle \lambda_{j}(u_{j}|\hat{q}_{j})|u_{j},\hat{\gamma}\rangle}$$

$$= \frac{\langle (\frac{\partial \hat{q}_{j}}{\partial \hat{q}_{A_{j}}})(\frac{\partial \lambda_{j}}{\partial \hat{q}_{j}})|u_{j},\hat{\gamma}\rangle}{\langle \lambda_{j}(u_{j}|\hat{q}_{j})|u_{j},\hat{\gamma}\rangle}$$
(2.157)

$$= \frac{\frac{\partial \lambda_{j}}{\partial \hat{q}_{j}} \left(u_{j} \middle| \hat{q}_{j}\right) \middle| u_{j} \hat{\gamma} \rangle}{\langle \lambda_{j} \left(u_{j} \middle| \hat{q}_{j}\right) \middle| u_{j}, \hat{\gamma} \rangle}$$
(2.158)

and, similarly

$$w_{B_{j}}(u_{j}|\hat{\gamma}) \stackrel{\Delta}{=} \frac{\lambda_{j}(u_{j}|\hat{q}_{A_{j}},\hat{q}_{B_{j}})}{\lambda_{j}(u_{j}|\hat{q}_{A_{j}},\hat{q}_{B_{j}})}$$

$$(2.159)$$

$$= \frac{\langle (\frac{\partial \hat{q}_{j}}{\partial \hat{q}_{B_{j}}})(\frac{\partial \lambda_{j}}{\partial \hat{q}_{j}}(u_{j} | \hat{q}_{j}) | u_{j}, \hat{\gamma}) \rangle}{\langle \lambda_{j}(u_{j} | \hat{q}_{j}) | u_{j}, \hat{\gamma} \rangle}$$

$$= \frac{\langle \lambda_{j}(u_{j} | \hat{q}_{j}) | u_{j}, \hat{\gamma} \rangle}{\langle \lambda_{j}(u_{j} | \hat{q}_{j}) | u_{j}, \hat{\gamma} \rangle}$$
(2.160)

$$= \frac{\langle \cos \beta_{j} \frac{\partial \lambda_{j}}{\partial \hat{q}_{j}} (u_{j} | \hat{q}_{j}) | u_{j}, \hat{\gamma} \rangle}{\langle \lambda_{j} (u_{j} | \hat{q}_{j}) | u_{j}, \hat{\gamma} \rangle}$$

$$(2.161)$$

Making use of (2.106) in (2.158) and (2.161) [and noting that $\hat{\gamma}$ in (2.106) included the phase difference parameter] gives

$$w_{A_{j}}(u_{j}|\hat{\gamma}) = \frac{\langle w_{j}(u_{j}|\hat{\gamma},\beta_{j})\lambda_{j}(u_{j}|\hat{q}_{j})|u_{j},\hat{\gamma}\rangle}{\langle \lambda_{j}(u_{j}|\hat{q}_{j})|u_{j},\hat{\gamma}\rangle}$$

$$(2.162)$$

$$= \langle \mathbf{w}_{j} (\mathbf{u}_{j} | \hat{\mathbf{y}}, \boldsymbol{\beta}_{j}) \mathbb{W} (\mathbf{u}_{j} | \hat{\mathbf{y}}, \boldsymbol{\beta}_{j}) | \mathbf{u}_{j}, \hat{\mathbf{y}} \rangle$$
 (2.163)

$$w_{B_{j}}(u_{j}|\hat{\gamma}) = \langle w_{j}(u_{j}|\hat{\gamma},\beta_{j})\cos\beta_{j}W(u_{j}|\hat{\gamma},\beta_{j})|u_{j},\hat{\gamma}\rangle$$
(2.164)

where

$$W(\mathbf{u}_{j} | \hat{\mathbf{y}}, \beta_{j}) \stackrel{\Delta}{=} \frac{\lambda_{j}(\mathbf{u}_{j} | \hat{\mathbf{q}}_{j})}{\langle \lambda_{j}(\mathbf{u}_{j} | \hat{\mathbf{q}}_{j}) | \mathbf{u}_{j}, \hat{\mathbf{y}} \rangle} > 0$$

$$(2.165)$$

is a weighting factor which essentially modifies the (uniform) a priori distribution of $\beta_{\hat{J}},$ giving an a posteriori one conditioned on $u_{\hat{J}}$ and $\hat{\gamma},$ i.e.

$$p(\beta_{j}|u_{j},\hat{\gamma}) = W(u_{j}|\hat{\gamma},\beta_{j})p(\beta_{j})$$
(2.166)

(Clearly

$$\int_{-\frac{1}{2}}^{\frac{1}{2}} p(\beta_{j} | u_{j}, \hat{\gamma}) d\beta_{j} = \langle W(u_{j} | \hat{\gamma}, \beta_{j}) | u_{j}, \hat{\gamma} \rangle = 1, \qquad (2.167)$$

independent of u_j , $\hat{\gamma}$, as expected.) A more explicit form for w_{A_j} results from the substitution of (2.95) for λ_j and (2.107) for w_j into (2.162);

writing the expectations in integral form and taking advantage of the even symmetry wrt β_i (i.e. as cos β_i in \hat{q}_i) gives:

$$w_{A_{j}}(u_{j}|\hat{y}) = \frac{\int_{0}^{\pi} [4u_{j}\frac{M_{1}}{m_{0}} (4\hat{q}_{j}u_{j})-1] M_{o}(4\hat{q}_{j}u_{j})\exp(-q_{j})d\beta_{j}}{\int_{0}^{\pi}M_{o}(4\hat{q}_{j}u_{j})\exp(-q_{j})d\beta_{j}}$$
(2.168)

or, in terms of the more familiar modified Bessel functions of the first kind, $\mathbf{I}_0,$ and $\mathbf{I}_1,$

$$w_{A_{j}}(u_{j}|\hat{y}) = \frac{\int_{0}^{\pi} [(\hat{q}_{j})^{\frac{1}{2}} \frac{I_{1}}{I_{0}} (2 (\hat{q} u_{j})^{\frac{1}{2}}) - 1] I_{0}(2 (\hat{q} u_{j})^{\frac{1}{2}}) \exp(-\hat{q}_{j}) d\beta_{j}}{\int_{0}^{\pi} I_{0}(2 (\hat{q}_{j}u_{j})^{\frac{1}{2}}) \exp(-\hat{q}_{j}) d\beta_{j}} (2.169)$$

Substituting the approximations (for any real z)

$$\frac{I_1}{I_0} (z) \approx \frac{z}{(4+z^2)^{\frac{1}{2}}}$$
 (good to about 4%) (2.170)

$$I_o(z) \approx \frac{\exp[(4+z^2)^{\frac{1}{2}} - \frac{2}{1+z}]}{(1+2\pi z)^{\frac{1}{2}}}$$
 (good to about 7%) (2.171)

and the following expansion for $\boldsymbol{\hat{q}}_{i}$

$$\hat{q}_{j} = \hat{q}_{A_{j}} (1 + B_{j} \cos \beta_{j})$$
(2.172)

where

$$B_{j} \stackrel{\hat{q}_{B_{j}}}{=} \frac{\hat{q}_{B_{j}}}{\hat{q}_{A_{j}}}$$
 (2.173)

(and, by virtue of (2.139)

$$-1 \le B_i \le +1$$
 (2.174)

gives

$$w_{A_{j}} = \frac{\int_{o}^{\pi} w_{j} L_{j} d\beta_{j}}{\int_{o}^{\pi} L_{j} d\beta_{j}}$$
 (2.175)

$$w_{B_{j}} = \frac{\int_{0}^{\pi} w_{j} \cos \beta_{j} L_{j} d\beta_{j}}{\int_{0}^{\pi} L_{j} d\beta_{j}}$$
(2.176)

where

$$w_{j} = \frac{u_{j}}{(1 + \hat{q}_{A_{j}} u_{j} (1 + B_{j} \cos \beta_{j}))^{\frac{1}{2}}} - 1$$
 (2.177)

and

$$\exp\left[2\left(\left(1+\hat{q}_{A_{j}}^{u_{j}}\right)^{(1+B_{j}\cos\beta_{j})}\right)^{\frac{1}{2}} - \frac{1}{1+2\left(\hat{q}_{A_{j}}^{u_{j}}\right)^{\frac{1}{2}}\left(1+B_{j}\cos\beta_{j}\right)^{\frac{1}{2}}}\right) - q_{A}\left(1+B_{j}\cos\beta_{j}\right)^{\frac{1}{2}}$$

$$L_{j} = \frac{\Delta}{\left(1+4\pi\left(\hat{q}_{A_{j}}^{u_{j}}\right)^{\frac{1}{2}}\left(1+B_{j}\cos\beta_{j}\right)^{\frac{1}{2}}\right)^{\frac{1}{2}}}$$

$$(2.178)$$

These last models, (2.175) and (2.176), were the basis of the calculations below.

Substituting (2.148) for $\Lambda(u|\hat{y})$ into (2.59) for $\Phi(\hat{y})$ gives

$$\begin{split} \Phi(\hat{\gamma}) &= D_{A}(\hat{\gamma}) H_{W_{A}}(\hat{\gamma}) D_{A}^{T}(\hat{\gamma}) + D_{A}(\hat{\gamma}) H_{W_{AB}}(\hat{\gamma}) D_{B}^{T}(\hat{\gamma}) \\ &+ (D_{A}(\hat{\gamma}) H_{W_{AB}}(\hat{\gamma}) D_{B}^{T}(\hat{\gamma}))^{T} + D_{B}(\hat{\gamma}) H_{W_{B}}(\hat{\gamma}) D_{B}^{T}(\hat{\gamma}) \end{split} \tag{2.179}$$

where, noting that now

$$u = u(\gamma, \beta_{11}, n), \qquad (2.180)$$

the J x J matrices H_{W_A} , H_{W_B} , and $H_{W_{AB}}$ are given by the following:

$$H_{W_{\underline{A}}}(\hat{\gamma}) \stackrel{\triangle}{=} \langle w_{\underline{A}}(u(\gamma, \beta_{\underline{u}}, n) | \hat{\gamma}) w_{\underline{A}}^{T}(u(\gamma, \beta_{\underline{u}}, n) | \hat{\gamma}) | \gamma = \hat{\gamma} \rangle$$
(2.181)

$$\mathbf{H}_{\mathbf{w}_{\mathbf{B}}}(\hat{\gamma}) \stackrel{\Delta}{=} \langle \mathbf{w}_{\mathbf{B}}(\mathbf{u}(\gamma, \beta_{\mathbf{u}}, \mathbf{n}) | \hat{\gamma}) \mathbf{w}_{\mathbf{B}}^{\mathbf{T}}(\mathbf{u}(\gamma, \beta_{\mathbf{u}}, \mathbf{n}) | \hat{\gamma}) | \gamma = \hat{\gamma} \rangle$$
(2.182)

$$\mathbf{H}_{\mathbf{w}_{AB}}(\hat{\mathbf{y}}) \stackrel{\triangle}{=} \langle \mathbf{w}_{A}(\mathbf{u}(\mathbf{y}, \boldsymbol{\beta}_{\mathbf{u}}, \mathbf{n}) | \hat{\mathbf{y}}) \mathbf{w}_{B}^{T}(\mathbf{u}(\mathbf{y}, \boldsymbol{\beta}_{\mathbf{u}}, \mathbf{n}) | \hat{\mathbf{y}}) | \mathbf{y} = \hat{\mathbf{y}} \rangle$$
(2.183)

in which these averages are taken wrt to the noise n and phase difference $\beta_{\mbox{\scriptsize i}}$ in u. Assurances given by the LOE theory that

$$0 = \langle \Lambda(\mathbf{u}(\gamma, \beta_{11}, \mathbf{n}) | \hat{\gamma}) | \gamma = \hat{\gamma} \rangle$$
 (2.184)

 $= D_{A}(\hat{\gamma}) < w_{A}(u(\gamma, \beta_{u}, n) | \hat{\gamma}) | \gamma = \hat{\gamma}) + D_{B}(\hat{\gamma}) < w_{B}(u(\gamma, \beta_{u}, n) | \hat{\gamma}) | \gamma = \gamma > (2.185)$ strongly suggest that

$$\langle w_{A}(u(\gamma,\beta_{u},n)|\hat{\gamma})|\gamma=\hat{\gamma}\rangle = 0$$
 (2.186)

$$\langle w_{\mathbf{B}}(\mathbf{u}(\gamma, \beta_{\mathbf{u}}, \mathbf{n}) | \hat{\gamma}) | \gamma = \hat{\gamma} \rangle = 0$$
 (2.187)

and a simulation study of the processes $\mathbf{w}_{A}(\mathbf{u} \mid \hat{\mathbf{y}})$ and $\mathbf{w}_{B}(\mathbf{u} \mid \hat{\mathbf{y}})$, using numerical approximations of (2.175) and (2.176) (discussed below) respectively, gave support for (2.186) and (2.187), as well as strong evidence that

$$\langle w_{A_{i}}(u_{i}(\gamma,\beta_{u_{i}},n_{i})|\hat{\gamma})w_{A_{j}}(u_{j}(\gamma,\beta_{u_{j}},n_{j})|\hat{\gamma})|\gamma=\hat{\gamma}\rangle = \begin{cases} 0 & i \neq j \\ h_{w_{A_{j}}}(\hat{\gamma}), & i=j \end{cases}$$

$$\langle w_{B_{i}}(u_{i}(\gamma,\beta_{u_{i}},n_{i})|\hat{\gamma})w_{B_{j}}(u_{j}(\gamma,\beta_{u_{j}},n_{j})|\hat{\gamma})|\gamma=\hat{\gamma}\rangle = \begin{cases} 0 & i \neq j \\ h_{w_{A_{j}}}(\hat{\gamma}), & i=j \end{cases}$$

$$\langle w_{B_{i}}(u_{i}(\gamma,\beta_{u_{i}},n_{i})|\hat{\gamma})w_{B_{j}}(u_{j}(\gamma,\beta_{u_{j}},n_{j})|\hat{\gamma})|\gamma=\hat{\gamma}\rangle = \begin{cases} 0 & i \neq j \\ h_{w_{B_{j}}}(\hat{\gamma}), & i=j \end{cases}$$

$$\langle w_{B_{i}}(u_{i}(\gamma,\beta_{u_{i}},n_{i})|\hat{\gamma})w_{B_{j}}(u_{j}(\gamma,\beta_{u_{j}},n_{j})|\hat{\gamma}\rangle |\gamma=\hat{\gamma}\rangle = \begin{cases} 0 & i \neq j \\ h_{w_{B_{j}}}(\hat{\gamma}), & i=j \end{cases}$$

$$\langle w_{B_{i}}(u_{i}(\gamma,\beta_{u_{i}},n_{i})|\hat{\gamma})w_{B_{j}}(u_{j}(\gamma,\beta_{u_{j}},n_{j})|\hat{\gamma}\rangle |\gamma=\hat{\gamma}\rangle = \begin{cases} 0 & i \neq j \\ h_{w_{B_{j}}}(\hat{\gamma}), & i=j \end{cases}$$

$$\langle w_{B_{i}}(u_{i}(\gamma,\beta_{u_{i}},n_{i})|\hat{\gamma})w_{B_{j}}(u_{j}(\gamma,\beta_{u_{j}},n_{j})|\hat{\gamma}\rangle |\gamma=\hat{\gamma}\rangle = \begin{cases} 0 & i \neq j \\ h_{w_{B_{j}}}(\hat{\gamma}), & i=j \end{cases}$$

$$\langle w_{B_{i}}(u_{i}(\gamma,\beta_{u_{i}},n_{i})|\hat{\gamma}\rangle |\gamma=\hat{\gamma}\rangle = \begin{cases} 0 & i \neq j \\ h_{w_{B_{j}}}(\hat{\gamma}), & i=j \end{cases}$$

$$\langle w_{B_{i}}(u_{i}(\gamma,\beta_{u_{i}},n_{i})|\hat{\gamma}\rangle |\gamma=\hat{\gamma}\rangle = \begin{cases} 0 & i \neq j \\ h_{w_{B_{j}}}(\hat{\gamma}), & i=j \end{cases}$$

$$\langle w_{B_{i}}(u_{i}(\gamma,\beta_{u_{i}},n_{i})|\hat{\gamma}\rangle |\gamma=\hat{\gamma}\rangle = \begin{cases} 0 & i \neq j \\ h_{w_{B_{j}}}(\hat{\gamma}), & i=j \end{cases}$$

$$\langle w_{B_{i}}(u_{i}(\gamma,\beta_{u_{i}},n_{i})|\hat{\gamma}\rangle |\gamma=\hat{\gamma}\rangle = \begin{cases} 0 & i \neq j \\ h_{w_{B_{j}}}(\hat{\gamma}), & i=j \end{cases}$$

$$\langle w_{A_{\mathbf{i}}}(u_{\mathbf{i}}(\gamma,\beta_{u_{\mathbf{i}}},n_{\mathbf{i}})|\hat{\gamma})w_{B_{\mathbf{j}}}(u_{\mathbf{j}}(\gamma,\beta_{u_{\mathbf{j}}},n_{\mathbf{j}})|\hat{\gamma})|\gamma=\hat{\gamma}\rangle = \begin{cases} 0 & i \neq j \\ h_{w_{AB_{\mathbf{j}}}}(\hat{\gamma}), & i=j \end{cases}$$

$$(2.190)$$

and, on the basis of these conclusions, the matrices $\mathbf{H}_{\mathbf{W}_{A}}(\hat{\gamma})$ and $\mathbf{H}_{\mathbf{W}_{B}}(\hat{\gamma})$ which are the covariances of processes $\mathbf{W}_{A}(\mathbf{u}|\hat{\gamma})$ and $\mathbf{W}_{B}(\mathbf{u}|\hat{\gamma})$ local to $\gamma-\hat{\gamma}=0$, and the matrix $\mathbf{H}_{\mathbf{W}_{AB}}(\hat{\gamma})$, the cross-variance of the processes \mathbf{W}_{A} and \mathbf{W}_{B} local to $\gamma-\hat{\gamma}=0$, were taken as diagonal, i.e.

$$H_{WA}(\hat{y}) = Diag(---, h_{WAj}(\hat{y}), ---), J \times J$$
 (2.191)

$$H_{W_{B}}(\hat{y}) = Diag(---, h_{W_{Bj}}(\hat{y}), ---), J \times J$$
 (2.192)

$$H_{WAB}(\hat{y}) = Diag(---, h_{WAB_{\hat{i}}}(\hat{y}), ---), J \times J$$
 (2.193)

where definitions for h $(\hat{\gamma})$, h $(\hat{\gamma})$ and h $(\hat{\gamma})$ were taken from $\hat{\beta}_j$ $\hat{\beta}_j$ equations (2.188), (2.189) and (2.190), respectively, above.

Efforts to use (2.175), (2.176), (2.188), (2.189) and (2.190) and

obtain approximations, respectively, for w_{A_j} , w_{B_j} , $h_{w_{A_j}}$, $h_{w_{B_j}}$, $h_{w_{AB_j}}$, and $h_{w_{AB_j}}$, analogous to those in (2.116) and (2.123) for w_j and h_{w_j} , respectively, in the optimal design, were <u>not</u> successful. As indicated above, it was necessary to use numerical procedures to perform the averaging indicated in the calculations of $w_{A_j}(u_j|\hat{\gamma})$, $w_{B_j}(u_j|\hat{\gamma})$ and $\Phi(\hat{\gamma})$). Numerical versions of (2.175) and (2.176) were used to calculate $w_{A_j}(u|\hat{\gamma})$ and $w_{B_j}(u|\hat{\gamma})$ in which integrations wrt β were replaced by simulation averages -- i.e. by summations over on index set of LMAX values of β taken uniformly over the interval $[0,\pi]$, with due regard for the dynamic range of the computing machine. The forms used are, as follows, suppressing the "j" subscript temporarily:

$$w_{A} = \left(\frac{\frac{2}{2} \left(\frac{1}{h_{a_{\ell}}}\right)}{\max_{\ell} \left(1, h_{\ell}\right)}\right) \left(\frac{f_{s_{A}}}{f_{s}}\right)$$

$$(2.194)$$

$$w_{B} = \left(\frac{\frac{\max (1, |h_{b_{\ell}}|)}{\ell}}{\max (1, h_{\ell})}\right) \left(\frac{f_{s_{B}}}{f_{s}}\right)$$
(2.195)

where

$$h_{\ell} = \frac{1}{(1 + 4\pi (q_{\Lambda} u)^{\frac{1}{2}} (1 + B\cos\beta_{\ell})^{\frac{1}{2}})^{\frac{1}{2}}}$$
(2.196)

$$h_{a_{\ell}} = (-1 + \frac{u}{(1 + q_{A}u(1 + B\cos\beta_{\ell}))^{\frac{1}{2}}}) h_{\ell}$$
 (2.197)

$$h_{b_{\ell}} = h_{a_{\ell}} \cos \beta_{\ell} \tag{2.198}$$

$$f_{s} = \sum_{\ell} h_{\ell} \exp(g_{\ell} - g_{m}). \qquad (2.199)$$

$$f_{s_{A}} = \sum_{\ell}^{LMAX} h_{a_{\ell}} \exp(g_{\ell} - g_{m_{a}})$$
 (2.200)

$$f_{s_{B}} = \sum_{\ell}^{LMAX} h_{b_{\ell}} \exp(g_{\ell} - g_{m_{b}})$$
 (2.201)

$$g_{m} = \ln(\text{LMAX}) + \ln \left(\max_{\ell}(1, h_{\ell}) + \max_{\ell}(g_{\ell}) - \text{EXPMAX}\right)$$
 (2.202)

$$g_{m_a} = \ln(LMAX) + \ln(\max_{\ell}(1, |h_{a_{\ell}}|) + \max_{\ell}(g_{\ell}) - EXPMAX \qquad (2.203)$$

$$g_{m_{b}} = \ln(LMAX) + \ln(\max_{\ell}(1, |h_{b_{\ell}}|) + \max_{\ell}(g_{\ell}) - EXPMAX \qquad (2.204)$$

and

EXPMAX
$$\stackrel{\triangle}{=}$$
 ln(largest REAL variable representable on the computer) (2.205)

$$(\tilde{2} 88. \text{ on the PDP-11, } 322. \text{ on the CDC Cyber 172})$$
 (2.206)

These equations were the basis for the simulation study that led to the conclusions of whiteness, equations (2.186) thru (2.190), and the consequent diagonality of $\mathbf{H}_{\mathbf{W}_{A}}$, $\mathbf{H}_{\mathbf{W}_{B}}$, and $\mathbf{H}_{\mathbf{W}_{A}}$, (2.191) thru (2.193). These same equations were used in a numerical study of \mathbf{W}_{A} and \mathbf{W}_{B} as functions \mathbf{u}_{j} , \mathbf{q}_{A} and \mathbf{B}_{j} in an effort to find approximating functions,

$$w_{A_j}(u_j|q_{A_j},B_j), w_{B_j}(u_j|q_{A_j},B_j)$$

"after the fact", again without success. As a result

- i. The numerical computation of w_{A_j} , w_{B_j} , given u_j , q_{A_j} , and B_j , equations (2.194) thru (2.204) had to be programmed as part of the receiver design, to run "on-line" (with a substantial increment in processing time). More will be said about this in the simulation discussion in the next chapter.
- ii. Also, the second-order averages, h , h and h , associated ${}^wAB_{\mbox{ j}}$ ${}^wB_{\mbox{ j}}$ with the calculation of Φ could not be adequately approximated

in closed-form, and numerical averages based on (2.188) thru (2.190) had to be done.

These latter calculations will be summarized at this point in the discussion since they were done "off-line" and hence were not part of the receiver simulation per se, but more a part of the design.

As (2.188) thru (2.190) suggests, the second-order averages had to be taken wrt the $\beta_{u_{\,\underline{i}}}$ -variable and the noise $n_{\,\underline{j}}$ in the observation sample, $\mathbf{u_i}$, appearing as an argument of the conditional mean processes $\mathbf{w_{A_i}}$, $\mathbf{w}_{\mathbf{B}_{\mathbf{i}}}$ -- clearly a very lengthy process but one fortunately that could be done off-line. Such an approach was used, but the effort then to find approximating functions "after the fact" was again not successful, and a plan was pursued involving calculating and storing many values of the second-order averages in tables off-line, then using table-lookup procedures indexed by $\boldsymbol{q}_{A_{\hat{i}}}$ and $\boldsymbol{B}_{\hat{j}}$ and interpolation on-line to calculate $\boldsymbol{\varphi}(\boldsymbol{\hat{\gamma}})$.

To improve the accuracy of these results and more nearly quarantee the non-negativeness of the calculated $\Phi(\hat{\gamma})$, the Φ -matrix was determined element-wise, as follows:

$$\Phi_{\ell i} = \Phi_{i \ell} = \sum_{j=1}^{J} \left[s_{w_{A_{j}}}^{D_{A_{ij}}} - s_{w_{B_{j}}}^{D_{B_{ij}}} \right] \left(s_{w_{A_{j}}}^{D_{A_{\ell j}}} - s_{w_{B_{j}}}^{D_{B_{\ell j}}} \right) \\
+ \left(1 + R_{AB_{j}}^{D_{S_{w_{A_{j}}}}} \right) s_{w_{A_{j}}}^{S_{w_{B_{j}}}} \left(D_{A_{ij}}^{D_{B_{\ell j}}} + D_{A_{\ell j}}^{D_{B_{ij}}} \right) \right] \qquad (2.207)$$

where

$$s_{W_{A_{j}}} \stackrel{\Delta}{=} (h_{W_{A_{j}}})^{\frac{1}{2}}, \quad s_{W_{A_{j}}} > 0$$

$$s_{W_{B_{j}}} \stackrel{\Delta}{=} (h_{W_{B_{j}}})^{\frac{1}{2}}, \quad s_{W_{B_{j}}} > 0$$
(2.208)

$$s_{w_{B_{i}}} \stackrel{\Delta}{=} (h_{w_{B_{i}}})^{\frac{1}{2}}, \quad s_{w_{B_{i}}} > 0$$
 (2.209)

$$R_{AB_{j}} \stackrel{\triangle}{=} \frac{\sum_{w_{AB_{j}}}^{h_{w_{AB_{j}}}}}{\sum_{w_{A_{j}}}^{w_{AB_{j}}}}, -1 \le R_{AB_{j}} \le +1$$
 (2.210)

The averaging associated with these calculations also was done by simulation rather than by using numerical integration of the associated probability integrals. In particular, suppressing the <u>above</u> "j" subscript temporarily and considering (2.136) and (2.172) then clearly u(j) in (2.48) can be written without confusion as

$$u = q(q_A, B, \beta_u) + 2n_c[q(q_A, B, \beta_u)]^{\frac{1}{2}} + n_c^2 + n_s^2$$
 (2.211)

$$= u(\beta_u, n | q_A, B)$$
 (2.212)

where, of course $q_A = q_A(\gamma)$ and $B=B(\gamma)$. Then $w_A(j)$ can be denoted as

$$w_{A}(u|\hat{q}_{A}, \hat{B}) = w_{A}(u(\beta_{u}, n|q_{A}, B)|\hat{q}_{A}, \hat{B})$$
 (2.213)

and with this notation the calculation of $s_{w_{\Lambda}}$ is described, as follows

$$s_{w_{A}} = \left[\frac{1}{L_{\text{max}}J_{\text{max}}} \sum_{\substack{1=1 \ E=1}}^{L_{\text{max}}J_{\text{max}}} \sum_{\substack{1=1 \ E=1}}^{M_{\text{max}}} w_{A}^{2}(u(\beta_{u_{\ell}}, n_{i} | \hat{q}_{A}, \hat{B}) | \hat{q}_{A}, \hat{B})\right]^{\frac{1}{2}}$$
(2.214)

$$= S_{W_{A}}(\hat{q}_{A}, \hat{B})$$
 (2.215)

and similarly for s_{W_B} , etc. where the components n_{c_i} , n_{s_i} of the J_{max} noise vectors n_i were drawn from a Gaussian pseudorandom noise generator (with mean zero, variance 0.5, see (2.11)) and the L_{max} values of β_{u_k} were taken uniformly from the interval $[0,\pi]$. Values for L_{max} and $J_{n_{max}}$ used were

$$L_{\text{max}} = 11$$
 (2.216)

$$J_{n_{max}} = 400$$
 (2.217)

for each (q_A, B_j) point. In building the tables 300 (q_A, B_j) points were employed distributed generally, as follows

$$0.1 \le q_{A_{\hat{j}}} \le 10^8$$
 (25 values) (2.218)

$$0.01 \le B_{j} \le 0.990$$
 (12 values) (2.219)

and values for $\ln(s_{w_{A_j}})$, $\ln(s_{w_{B_j}})$ and R_{AB_j} were calculated and stored. These off-line calculations were done by PROGRAM WLOGSW, associated subroutines WAVGS and WAWB, and FUNCTION GAUSS, which are all included in Appendix A. Values calculated for $\ln(s_{w_{A_j}})$, $\ln(s_{w_{B_j}})$, and R_{AB_j} are given in Tables 2.1, 2.2 and 2.3 respectively.

Then, in the receiver, for each $(\hat{q}_{A_j}, \hat{B}_j)$ point associated with the estimate $\hat{\gamma}(k$ k-1), the tables were entered and

i. Values \hat{q}_{A_i} , $\hat{q}_{A_{i+1}}$, \hat{b}_i , \hat{b}_{i+1} from the tables were found, such that

$$\hat{\mathbf{q}}_{\mathbf{A}_{\hat{\mathbf{i}}}} \leq \hat{\mathbf{q}}_{\mathbf{A}_{\hat{\mathbf{j}}}} \leq \hat{\mathbf{q}}_{\mathbf{A}_{\hat{\mathbf{i}}+1}} \tag{2.220}$$

$$\hat{\mathbf{B}}_{i} \leq \hat{\mathbf{B}}_{j} < \hat{\mathbf{B}}_{i+1} \tag{2.221}$$

ii. Then, linear interpolation between calculated averages in the table was done, using the general formula

$$f(x_1 + \Delta x, y_1 + \Delta y) = f(x_1, y_1) + \frac{f(x_2, y_1) - f(x_1, y_1)}{x_2 - x_1} \Delta x$$

$$+ \frac{f(x_1, y_2) - f(x_1, y_1)}{y_2 - y_1} \Delta y$$

$$+ \frac{f(x_1, y_1) + f(x_2, y_2) - f(x_1, y_2) - f(x_2, y_1)}{(x_2 - x_1)(y_2 - y_1)} \Delta x \Delta y$$

iii. The interpolated values of $\ln (s_{w_{A_{j}}})$, $\ln (s_{w_{B_{j}}})$ were exponentiated),

4

Table 2.1 Ln (s_{wA} (q_A, B_j))

B *	.010	. 026	.040	.060	.100	.200	.300	.500	.700	.900	•950	•990
QA:											• •	_ 11
•1000	11	11	11	11	11	11	11	11	11	11	11	11
∙1778	16	10	16	16	16	16	16	16	16	16	16	16
•3162	~.23	23	23	23	23	23	23	23	23	24	24	24
.5623	33	33 '	33	33	33	33	-,33	33	34	34	35	35
1.000	47	47	~.47	47	47	47	47	48	49	50	50	~.51
1.770	65	65	65	65	66	-,66	66	68	69	71	72	72
3.162	SU	90	91	91	91	91	92	95	-,97	 98	97	97
5.623	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.3	-1.3	-1.2	-1.2	-1.2
10.00	-1.5	-1.5	~1.5	-1.5	-1.5	-1.5	-1.6	-1.7	-1.7	-1.5	-1.4	-1.3
17.78	-1.0	-1.8	-1.8	-1.8	-1.8	-1.9	-1.9	-2.1	-2.0	-1.7	~1.6	-1.4
31.62	-2.1	-2.1	-2.1	-2.1	-2.1	-2.2	-2.3	-2.4	-2.4	-2.0	-1. 8	-1.6
56.23	-2.3	-2.3	-2.4	-2 • 4	-2.4	-2.6	-2.7	-2.8	-2.7	-2.4	-2.1	-1.7
100.0	-2.0	-2.6	-2.7	-2.7	-2.8	-3.0	-3.1	-3.1	-3.0	-2.7	-2.4	-1.9
177.3	-2.5	-2.4	-3.0	-3.0	-3.1	-3.3	-3.4	-3.4	-3.4	-3.0	-2.7	-2.0
316.2	-3.2	-3.2	-3.3	-3.3	-3.5	-3.7	-3.8	-3.8	-3.6	-3.2	-2.9	-2.2
562.3	-3.5	-3.5	-3.6	-3.7	-3.9	-4.0	-4.1	-4.1	-3.8	-3.3	-3.1	-2.3
1000.	-3.0	-3.0	-4 • G	-4.1	-4.3	-4.4	-4.4	-4.3	-3.9	-3.5	-3.2	-2.6
1776.	-4.1	-4.2	-4.4	-4.5	-4.6	-4.7	-4.7	-4.4	-4.1	-3.7	-3.4	-2.8
3162.	-4.4	-4.0	-4.7	-4.9	-5.0	-5.1	-4.9	-4.5	-4.3	-3.9	-3.7	-3.1
5623.	-4.7	-4.9	-5.1	-5.2	-5.3	-5.3	-5.0	-4.7	-4.6	-4.2	-4.0	-3.4
10000	-5.1	-5.3	-5.5	-5.5	-5.6	-5.4	-5.1	-5.0	-4.8	-4.5	-4.3	-3.7
.1000ä+0o	-0.0	-t.7	-6.8	-6.6	-6.3	-6.2	-6.1	-6.0	-5.9	-5.6	-5.4	-4.9
.1003E+07	-7.9	-7.7	-7.4	-7.3	-7.3	-7.2	-7.2	-7.2	-7.1	-6.8	-6.6	-6.0
-1300E+08	-8.6	-0.5	-8.4	_R 4	-8.4	-8.4	-8.4	-8.3	-8.2	-7.9	-7.7	-7.2
.1000£+09	-9.0	-9.5	-9.5	-9.5	-9.5	-9.5	-9.5	-9.5	-9.4	-9.1	-8.9	-8.3

Table 2.2 Ln $(s_{\psi_{\beta_{j}}}(q_{A_{j}}, B_{j}))$

ß =	.010	.020	.040	.060	.100	.200	.300	•500	•700	•900	• 950	•990
QA:								2.0	-3.5	-3.2	-3.1	-3.1
,1000	-7.8	-7.1	-6.4	-6.0	-5.5	-4.8	-4.4	-3.9		-2.8	-2.7	-2.7
.1778	-7.4	-6.7	-6.0	-5.6	-5.1	-4 . 4	-4.0	-3.5	-3.1	-2.4	-2.3	-2.3
.3162	-0.9	-6.2	~>·5	-5.1	-4.6	-3.9	-3.5	-3.0	-2.7		-1.9	-1.9
.5623	-6.5	-5.8	- 5•1	-4.7	-4.2	-3.5	-3 • 1	-2.6	-2.2	-2.0	-1.6	-1.5
1.000	-6.1	-5.4	-4.7	-4.3	- 3.8	-3 • 1	-2.7	-2.2	-1.8	-1.6		-1.3
1.778	-5.7	-5.1	-4.4	-4.0	-3.4	-2.8	-2.4	-1.9	-1.6	-1.4	-1.3	-1.2
3.162	-5.0	-4.9	-4.2	-3.8	-3.3	-2.6	-2.2	-1.7	-1.5	-1.3	-1.2	-1.2
5.623	-5.5	-4.9	-4.2	- 3.8	- 3,3	-2.6	-2 • 2	-1.8	-1.5	-1.3	-1.3	
10.00	-5.6	-4.9	-4.2	-3.8	-3.3	-2.6	-2.3	-1.9	-1.7	-1.5	-1.4	-1.3
17.78	-5.6	-4.9	-4.2	-3,8	-3.3	-2.7	-2.4	-2.2.	-2.0	-1.7	-1.6	-1.4
31.62	-5.6	-4.9	-4.2	-3.8	-3.3	-2.8	-2.6	-2.5	-2.4	-2.0	-1.8	-1.6
56.23	-5.6	-4.9	-4.2	-3.8	-3.4	-2.9	-2.8	-2.8	-2.7	-2 • 4	-2.1	-1.7
100.3	-5.6	-4.9	-4.2	-3.9	-3.5	-3.1	-3.1	-3.1	-3.0	-2.7	-2.4	-1.9
177.8	-5.6	-4.9	-4.2	-3.9	-3.6	-3.4	-3.4	-3.4	-3.4	-3.0	-2.7	-2.0
316.2	-5.6	-4.9	-4.3	-4.0	-3.8	-3.7	-3.8	-3.8	-3.7	-3.2	-3.0	~2.2
562.3	-5.6	-4.9	-4.4	-4.1	-4.0	-4.0	-4.1	-4.1	-3.9	-3.5	-3.2	-2.4
1000.	-5.6	-5.J	-4.5	-4.3	-4.3	-4.4	-4-4	-4.4	-4.1	-3.7	-3.4	-2.6
1778.	-5.6	-5.0	-4.6	-4.6	-4.6	-4.7	-4 • ð	-4.6	-4.4	-3.9	-3.5	-2.9
3162.	-5.6	-5.1	-4.9	-4.9	-4.9	-5.1	-5.1	-4.8	-4.6	-4.1	-3.8	-3.2
	-5.7	-5.3	-5.1	-5.2	-5.3	-5.4	-5.3	-5.1	-4.9	-4.3	-4.1	-3.5
5623.			-5.5	-5.5	-5.6	-5.7	-5.5	-5.3	-5.1	-4.6	-4.4	-3.7
10000	-5.6	-5.2 -6.7	-6.8	-6.8	-6.7	-6.6	-6.5 .	-6.3	-6.1	-5.8	-5.5	-4.9
.1000E+06	-6.6		-7.8	-7,7	-7.7	-7.5	-7.5	-7.4	-7.3	-6.9	-6.7	-6.0
.10C0E+u7	-7.9	-8.0		-8.7	-8.7	-8.7	-8.7	-8.6	-8 . 4	-8.1	-7.8	-7.2
.1000 <u>E</u> +0E	<u>-9</u> •0	-6.9	-8.8		-9.8	-9.8	-9.8	-9.7	-9.6	-9.2	-9.0	-8.3
1000F+09	-10-	-9 • ¤	-9.8	-9.8	- 7 + 0	0	, • · ·	,				

Table 2.3 $R_{AB_j}(q_{A_j}, B_j)$

RAB1												
В #	.010	.626	•040	.060	.100	.200	.300	.500	.700	.900	.950	.990
QA: .1000	•14	.14	.14	.14	•14	•14	•14	•16	.18	.21 .34E-01	.21 .48E-01	.20 .49E-01
.1779	43E-01	43:-01	43E-01	-:43E-01	43E-01	-,41E-01	37E-01	26E-01	44E-02	12	10	96E-01
.3162.	~~.V10	16	16	16	16	16	16	15	14	24	24	23
.5623	24	24	24	24	24	24	24	24	25	37	37	37
1.000	·32	32	32	32	32	32	32	33	35	48	49	50
1.778	37	37	37	37	37	37	38	40	44	59	61	63
3.162	35	35	35	35	35	36	38	43	50		73 73	75
5.623	28	⊸.2੪	28	28	28	30	33	42	55	69	81	84
10.00	22	22	22	22	22	-,24	28	39	57	77	86	90
17.7da	18	18	18	18	19	21	25	39	59	81	89	94
31.62%	15	15	16	16	16	20	25	41	60	83	91	96
56.23 r	14	14	14	14	15	19	26	-,43	61	84	91	97
100.0%	13.	13	13	13	14	20	28	45	63	84	91	98
177•ປັ	12	12	12	13	14	21	-• 29	46	64	85		98
316.₽₹	11	11	12	12	14	22	30	47	65	85	9 0	98
562.	11	11	11	12	15	23	31	48	66	83	90	97
1000	11	11	11	12	15	23	31	48	66	82	89	97
1000 1776	10	10	11	12	15	24	32	48	62	81	⊶.89	97
31623	1Ó	492-01	11	13	16	24	31	47	57	82	89	96
5623	'9or-01	968-01	11	13	16	23	30	41	55	82	89	96
10000.	95E-J1	97c-01	11	13	16	22	29	37	59	82	88	
.1000E+0	6 -7.93e-01	10	12	10	10	14	26	-, 42	56	78	86	96 96
.100JE+0		ole-01	35E-01	43E-01	87E-01	15	22	38	56	78	~. 86	96
.100JE+0	819t-01	15E-01	36E-01	47E-01	74E-01	15	22	38	56	7B	86	96
.1000E+0		Î>E-01	30E-01	44E-01	74E-01	15	22	38	56	78	86	. - • 9 6

and the results with the interpolated value of $R_{\mbox{AB}}$ were used in calculating $\Phi_{\mbox{2i}}$ via (2.207).

This completes the calculation of $\Lambda(u \mid \hat{\gamma})$ and $\Phi(\hat{\gamma})$, hence the description of the Scan Data Processor, for the Suboptimal Design.

The Tracking Loop for the Suboptimal Design is identical with that of the Optimal Design, except for changes due to the lower dimensions of the state and parameter vectors. Generally

- i. The last two rows of the state vector estimate and corresponding rows and/or columns of associated matrices were eliminated;
- ii. The last row of the parameter-vector (estimate) and corresponding rows and/or columns of associated matrices were eliminated.

This simple adaptation procedure results from the special formulations of the state- and parameter-vectors adopted. It was employed in the simulation easily and without problem.

This same general procedure was used also in obtaining the Non-Adaptive Design (recall (2.83), (2.84)) -- simply by (initializing $\hat{\gamma}_R$ =0 and then) pruning the several vectors and matrices back to the appropriate dimensions, starting with either the optimal or suboptimal designs (both give the same results). This too was used in simulation without problem.

This concludes the formal development of the receiver algorithms.

We turn next to the simulation studies and discussion of results.

SECTION III

SIMULATION STUDIES

The principal simulation result used in evaluating the performance of the various receiver designs was the calculated root mean square error (RMSE) (sample) statistic. A large number of studies of RMSE versus $\theta_{\rm sep}$ were conducted, where

$$\theta_{\text{sep}} \stackrel{\triangle}{=} \theta - \theta_{\text{R}} \tag{3.1}$$

These studies were parameterized, in general, by the following:

DSNRDB (or S/N)
$$\stackrel{\triangle}{=}$$
 20 $\log_{10} \alpha$ (3.2)

$$\rho \stackrel{\triangle}{=} \alpha_{R}/\alpha \tag{3.3}$$

$$\beta$$
, the phase difference at the beginning of the simulation run (3.4)

$$F_{sc} = w_{sc}/2\pi$$
, the scalloping rate (Hz) (3.5)

$$B_{MLS} \stackrel{\Delta}{=}$$
 the 3 db beam width of the MLS transmitting antenna (3.6)

$$B_{RCVR} \stackrel{\triangle}{=}$$
 the presumed 3 db beam width in the receiver of the MLS transmitting antenna (3.7)

Other RMSE studies performed included:

- 1. RMSE versus (B_{RCVR}/B_{MLS}) , parameterized by S/N, ρ , β , F_{sc} and θ_{sep} ; this study was deemed important because of the presumption in the Optimal and Suboptimal receivers of a value for the MLS ground (transmitting) antenna beam width, a parameter not currently transmitted in the preamble of the MLS signal.
- 2. RMSE versus F_{sc} , parameterized by S/N, ρ , β , θ_{sep} , B_{MLS} , B_{RCVR} .

PRESENTA PARE BLANK NOT HEMOD.

Two series of error time-history studies were conducted also, all runs in both cases being parameterized by the full set, S/N, ρ , β , F_{sc} , θ_{sep} , B_{MLS} , B_{RCVR} , as well as other variants, such as the presence or absence of the constraints imposed on the estimates, etc. One set of error time-history studies, termed Interference Acquisition scenario runs, evaluated the "pull-in" ability of the interference tracker for potential use in interference acquisition. The second set of error time-history studies, termed Crossing Multipath scenario runs, evaluated the tracking performance of the receiver designs in dynamic environments involving multipath interference which is initially out-of-beam, then closes to in-beam, crosses, and finally opens to out-of-beam.

A major portion of the research was devoted to simulation studies -- both program development and receiver performance evaluation. The programs used in the receiver performance studies, totaling about 100 pages of FORTRAN code, are listed in Appendix A and are briefly discussed in the first part of this section. The second part of this section presents a representative selection of data from the various simulation runs, and discusses the results.

A. SIMULATION MODELS

The bulk of the computation performed in the simulation was done in FORTRAN subroutines described as follows:

MLSSUB: Simulation of the environment (via a state-space model with "true"-state, x(k)) and the received (envelope) signal vector, u(k); we note here that within a scan the quantity '

$$\beta_{j} = \beta + \omega_{sc} T_{j}$$
 (3.7a)

is used as a better approximation of the phase difference (rather than simply β) in computing the jth sample, u, of the received envelope signal.

RCVR: Computation of the estimate, $\hat{\theta}(k|k)$, of the angular accordinate $\theta(k)$, given the observations vector, u(k);

CONTRL: Conduct of the simulation run, including performing all I/O operations, special initializations and performance evaluation calculations.

The macro-flow-charts in Figure 3.1 show the organizations of these routines and their interrelations.

The simulation main program, MLSSIM, simply establishes COMMON storages and calls MLSSUB. Subroutine MLSSUB calls a library gaussian pseudorandom number generator function GAUSS and the following two MLS functions, in addition to RCVR and CONTRL:

PMLS: The antenna selectivity function, $p_{MLS}(\theta_e)$, of the MLS transmitting antenna, used in constructing the observations vector u(k). The following -23 db sidelobe function was used in the study:

$$p_{MLS}(\theta_{e}) = \begin{cases} \pi/4, & |z| = 1\\ \cos \frac{\pi}{2} z \\ \frac{1 - z^{2}}{1 + 1} \end{cases}$$
 (3.8)

where
$$z \stackrel{\triangle}{=} 2.4\theta_e/B_{MLS}$$
 (3.9)

$$\theta_{\rm e} \stackrel{\Delta}{=} {\rm angle \ from \ beam \ center}$$
 (3.10)

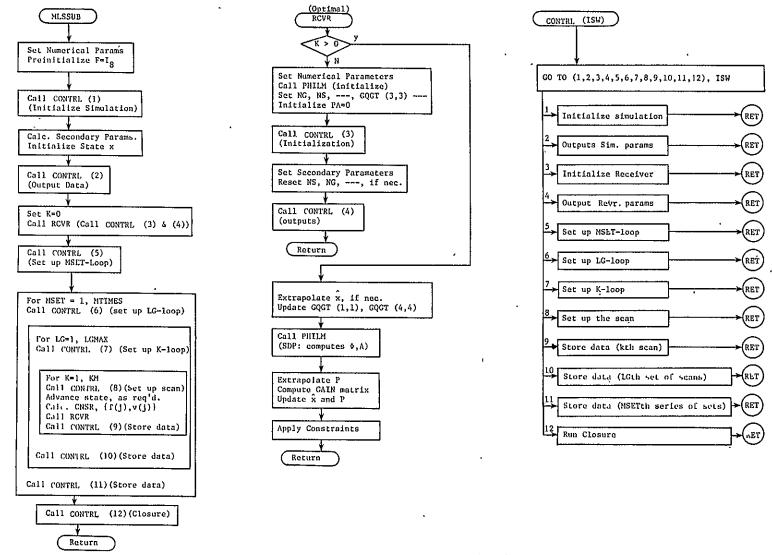


Figure 3.1 Flow Charts for MLSSUB, (OPT) RCVR, and CONTRL

THA: The antenna scanning function, $\theta_A(\tau)$, of the MLS transmitting antenna, used in constructing the vector $\mathbf{u}(\mathbf{k})$. The function in (2.124) above was specified in the MLS specifications and used in the study.

The programs MLSSIM, MLSSUB, THA, DFLTR1 (a 1st-order digital filtering subroutine used when the threshold receiver is running) and a BLOCK DATA program, MLS, collectively constituted a software module (or file), denoted MLSSIM. The function PMLS, and BLOCK DATA program PMLSID were put into a separate module, PMLS1, to facilitate changing the $p_{\rm MLS}(\cdot)$ function. The listouts of these and other programs found in Appendix A are grouped into modules.

Two scenarios of subroutine RCVR were used, which are distinguished by module (or file) names suggestive of their natures, as follows:

OPTRVR: The optimal structure, comprising the Scan Data Processor and the Tracking Loop; calls subroutine PHILM (which calculates SDP quantities Φ, Λ, and is described below) as well as matrix arithmetic subroutines MATSM, MATMUL and MATINV.

THDRVR: A design similar to present commercial approaches using thresholding principles [11]. The simulation model, which involved

- i) A 3db-below-peak threshold (referred to the linear envelope)
- ii) A 300 microsec tracking gate for interference exclusion.

- iii) A dwell gate for "loss-of-track"
 decisions
- iv) Input of the <u>log</u> envelope signal, filtered by a 25 KHz low pass filter.
- v) Error filtered with a 10 r/s bandwidth low pass filter for evaluation,

was developed to provide baseline data for performance comparisons. See the references [11], [4, pp. 25,26] and the program in Appendix A for further details. The program calls subroutine DFLTR1 to provide the 25 kHz filtering.

Two versions of PHILM were used, distinguished by module names, as follows:

PLOPT: The Scan Data Processor calculations of Φ , Λ for the Optimal design. This uses function THA, (2.124) above, and functions P and PDOT given below. We note here that in the calculation of matrix D in PLOPT, analogous to (3.7a), the quantity

$$\hat{\beta}_{j} = \hat{\beta} + \hat{w}_{sc} \tau_{j} \tag{3.10a}$$
 was used for $\hat{\beta}$ in (2.103) in an effort to improve the receiver performance by making use of the \hat{w}_{sc} -information at this point.

PLSUB: The SDP calculations of Φ , Λ for the Suboptimal design. This calls the same functions THA, P, PDOTused by PLOPT, preceeding, but also calls subroutines WAWBJ (which calculated "on-line" conditional averages

 w_A (u_j γ) and w_B (u_j γ) using (2.194), (2.195) and succeeding equations) and subroutine SWFCNS (which did the table look-up and necessary interpolation to produce the values s_{w_A} , s_{w_B} and r_{AB} (2.208),

(2.209) and (2.210) respectively needed to calculate matrix Φ via (2.207). See the program in Appendix A for further details.

The functions P, PDOT constitute the module POPT1 and are used by both versions of PHILM. They are described as follows:

P: The antenna selectively function $p(\theta_e)$ assumed in the receiver design to be in effect in the received signal vector u(k). The following -23 db sidelobe function was used in the study:

$$p(\theta_{e}) = \begin{cases} \pi/4, & |z| = 1\\ \frac{\cos \frac{\pi}{2} z}{1 - z^{2}}, & |z| \neq 1 \end{cases}$$
 (3.11)

where
$$z \stackrel{\Delta}{=} 2.4 \theta_e/B_{RCVR}$$
 (3.12)

$$\theta_{\rm e} \stackrel{\triangle}{=} {\rm angle \ from \ beam \ center}$$
 (3.13)

This is the same function as $p_{MLS}(\theta_e)$, (3.8), but it was programmed twice with distinct names to allow different functions to be used (alternate function were not studied, however). Figure 3.2 shows the function $p(\cdot)$, (3.11) above, centered in the same 65-sample window on the same sampling grid (FSAMP = 160 kHz, OMEGA = 20,000 Deg./sec.) as in the receiver.

```
RUN PPLOT

BMLS = 1.00000

OMEGA = 20000.0

FSAHP = 160000.

DTHETA = 0.125000

JMAX = 65

THEMIN = -4.00000

THEMAX = 4.00000
```

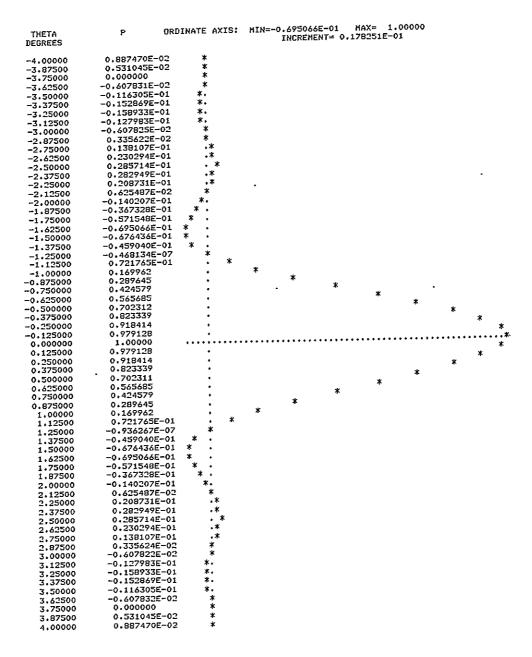


Figure 3.2 Antenna Selectivity function, $p(\theta)$, used

PDOT: The function $\frac{dp(\theta_e)}{d\theta_e}$. On the basis of (3.11) thru (3.13) the following was used:

$$\frac{\mathrm{dp}(\theta \mathrm{e})}{\mathrm{d}\theta \mathrm{e}} = \begin{cases} \frac{-0.3\pi}{\mathrm{B}_{\mathrm{RCVR}}} & \mathrm{signum}\ (z), \ |z| = 1 \\ \\ \frac{0.3\pi^2}{\mathrm{B}_{\mathrm{RVCR}}} \left(\frac{\cos(z+1)\pi/2 - \frac{\sin(z+1)\pi/2}{(z+1)\pi/2}}{(z+1)\pi/2} + \frac{\cos(z-1)\pi/2 - \frac{\sin(z-1)\pi/2}{(z-1)\pi/2}}{(z-1)\pi/2} \right) |z| \neq 1 \end{cases}$$

Several versions of subroutine CONTRL, distinguished by module names, as follows, were used, conducting the simulation through various types of scenarios and test runs:

CTLACQN: An interference acquisition scenario, testing the "pull-in" power of the interference tracking algorithm. Initially no interference is present and the interference tracker states are tethered to "idler" values, as follows:

$$\hat{\alpha}_{R_{o}} = 0.5 \hat{\alpha}$$
 (3.15)
$$\hat{\theta}_{R_{o}} = \hat{\theta} - 1.5 \text{ degrees}$$
 (3.16)
$$\hat{\theta}_{R_{o}} = 0 \text{ degrees/second}$$
 (3.17)
$$\hat{\beta}_{o} = \pi/2 \text{ radians}$$
 (3.18)
$$\hat{\omega}_{sc_{o}} = 0 \text{ radians/second}$$
 (3.19)

A step of interference then occurs with prescribed parameter values, the interference tracker is unterhered and the estimate error-time-histories are generated.

CTLCRMP: A crossing multipath scenario, testing the tracking abilities of a receiver design from an out-of-beam interference condition, thru a crossing in-beam condition to a out-of-beam situation again under prescribed conditions; error-time-histories are generated.

CTLMSTH: An RMS error versus θ_{sep} study in which, by a suitable nonzero assignment of w_{sc} , the effects of β are approximately averaged out as the statistical sample of desired size, 100 scans, evolves. 110 scans are calculated and the first 10 discarded in computing error statistics for each value of θ_{sep} . The program increments θ_{sep} and repeats the calculation for up to 13 values of θ_{sep} .

CTLOE: Another, more expensive, RMS error versus θ_{sep} study in which for each value of θ_{sep} β is stepped through 20 values uniformly spaced on the $(-\pi,\pi)$ interval and, for each value of β , 30 scans are generated, the first 10 being discarded and the latter 20 being used in the statistical calculations.

CTLMSSBB: An RMS error versus B ratio study, where

$$B_{\text{ratio}} \stackrel{\triangle}{=} B_{\text{RCVR}}/B_{\text{MLS}}.$$
 (3.20)

The study is performed in a manner similar to that in CTLMSTH above, including the use of nonzero w_{sc} .

7 values of $\boldsymbol{B}_{\text{ratio}}$ were used in the range

$$(10)^{-\frac{1}{2}} \le B_{\text{ratio}} \le (10)^{\frac{1}{2}}$$
 (3.21)

with

$$\begin{vmatrix}
B_{RCVR} &= 1^{\circ} \\
B_{MLS} &> 1^{\circ}
\end{vmatrix}$$
, when $B_{ratio} < 1$ (3.22)

and

$$\begin{vmatrix}
B_{RCVR} > 1^{\circ} \\
B_{MLS} = 1^{\circ}
\end{vmatrix}$$
, when $B_{ratio} > 1$ (3.23)

CTLMSFS: An RMS Error versus F_{sc} study. This study is also performed in a manner similar to that in CTLMSTH above, except that w_{sc} is assigned higher and higher integer multiples of the minimum value (0.135 Hz in AZIMUTH) which would integrate β over a 2π interval during a 100-scan time period.

Block data programs were included in many modules to initialize COMMON storages. A library of general math and utility programs was also used and is included in the program listings in Appendix A.

All simulation runs were made with Azimuth angle function data, though the option for elevation simulation was included in the programs. Parameter values written in storages are, as follows:

θ _A =	AZ 62.666667°	EL 30.666667°	(3.24)
θ _A min	-62.0°	0.00	(3.25)
$T = T^{s} = T^{s} = Rep. Rate = 1/T =$	6.233333 ms 6.6 ms 13.5 Hz	1.533333 ms 0.4 ms 40.5 Hz	(3.26) (3.27) (3.28)

Except as noted above for $B_{\mbox{ratio}}$ studies, values assigned $B_{\mbox{MLS}}$ and $B_{\mbox{RCVR}}$ were, as follows:

$$B_{MLS} = B_{RCVR} = 1^{\circ}$$
 (3.29)

Specification of the intensity of the interference was made using the parameter ρ defined in (3.3). As indicated above in connection with Figure 3.2, 65 samples were taken in each semiscan, i.e.

$$J = 130$$
 (3.30)

at the sampling rate

$$F_{\text{samp}} = 160 \text{ KHz} \tag{3.31}$$

with the 33rd and 98th samples occurring where the peaks of the direct path pulses were expected, based on $\hat{\theta}(k|k-1)$.

Estimation error was calculated in the expected manner, i.e. x-x, except for components associated with β , \hat{w}_{sc} (and \hat{w}_{sc} in the 6D LOE model). In these components, the differences in absolute values, e.g. $\left|\hat{\beta}\right| - \left|\hat{\beta}\right|$, were used for error evaluation to accommodate the ambiguity in these variables.

B. SIMULATION RUNS AND RESULTS

The results of nearly 50 runs are reported here in 23 plots and 23 tables. Table 3.1 summarizes the runs made--by type of run and CONTRL module, parameter values used, RCVR type used and figure numbers and table numbers in which the results appear. [In these discussions "OPTRVR" implies the use of modules OPTRVR and PLOPT (an abuse of terminology, perhaps), "SUBOPT" implies the use of modules OPTRVR and PLSUB.]

Figure 3.3 shows the computed RMS error (θ component) versus θ_{sep} for several S/N values for the OPTRVR, ρ =0.8. Figure 3.4 presents the

Table 3.1 Summary of Simulation Runs

TYRE OF KON	5/N		- Osep		Fsc	Kita	Becva	FIG	URE NOS	. (3.+) THORNR	TABLE OPERVE	NOS. (3) SUBOPT	REHARKS
(0141074)	\$ \$ 0 0 0 0 3 X	000000000000000000000000000000000000000	375 0/575	<u>\$</u> 180°	0.135#3	9	40	17 17 17 17 17 17 17 17 17 17 17 17 17 1	15) 88 6,7	5		10 11 12	Non-Adapt, also
PMCF (Osq =)	20	0.5	V	180° only every 18° 20 when 180° only		°	- †°	7	60-60-60		9		
PHSE (BROKENS)	20 30 30 20	0.5 0.5 0.5	/.5°	-180°	a 35H3	3.16° 40 1°	1° 4, 3.16°	ي م م ه			के ध ने ध		
HISTE (Fac)	30	0.8	/.5°	ذ	0 to 6 75 H, 47 25 to 60.75		10	10	. 1/		7 18 19 22 23	20	NO CONSTRAIN'S WITH CONSTR, Tethers, N.C. Tetherd, W.C.
Interfer Ara-	40	0.8	0.2.2.3° 5° 5° 5° 5° 5° 5° 5° 5° 5° 5° 5° 5° 5°	45°	0.643 7 2.54z 0643.	٥	•	13 1 5 16 17 17 15 16 17	42				
	14 40 40]°	-168° 45°	2,5Hz. 0.6Hz 51.5Hz. 0.6Hz	V		18	23 21				
Crossy + Multipoth	20 20	0.8 0.8	-2.75° to 2.3°	-168°	51.3 Hz,	10	1°	2 y 2 S	24 2 5	24 25			
								. '			4		

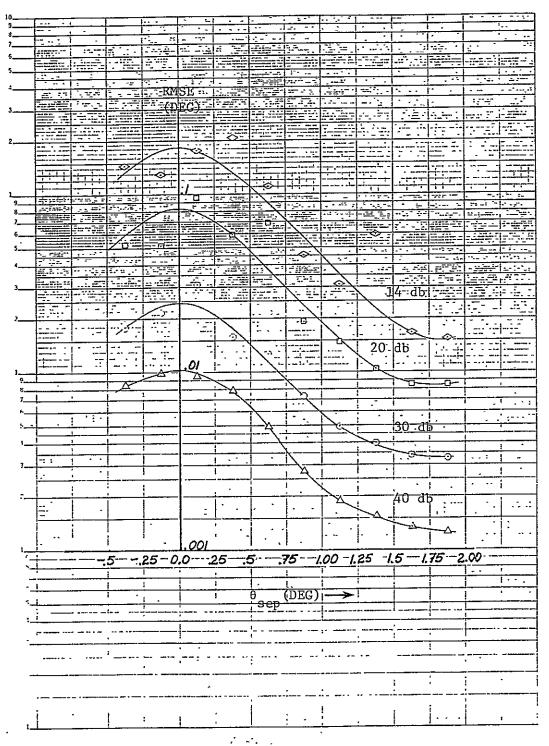


Figure 3.3 RMSE (θ_{sep}), OPTRVR, ρ =0.8

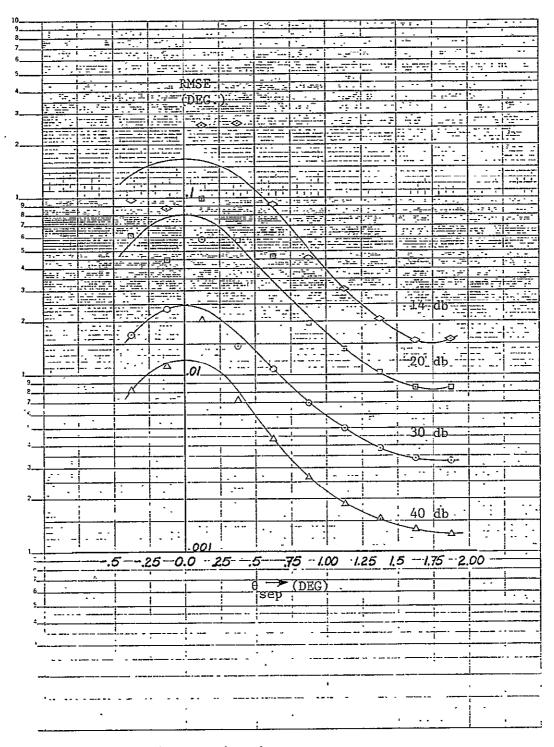


Figure 3.4 RMSE (θ_{sep}) , OPTRVR, ρ =0.5

same type of data for ρ =0.5. The scatter in the points for the lower S/N cases is due to noise; the apparent odd symmetry in the scatter about the origin is due to several causes:

- i. The lack of symmetry between the TO, FRO scans wrt the noise samples;
- ii. The effect of noise on the β -estimate (in one run, not included here, $\hat{\beta}$ was tethered to the true value β and the calculated RMSE $(\theta_{\text{sep}})(\theta\text{-component})$ exhibited more nearly the expected even symmetry wrt θ_{sep} .
- iii. The use of the same noise sample function for each data point.

Figures 3.5 thru 3.7 show comparisons of RMSE ($\theta_{\rm sep}$) for the receivers for various values of S/N and ρ . Figure 3.6, for example, shows that with S/N=20 db, ρ =0.8, the optimal design offers improvement by a factor up to about 30 over the threshold receiver. The suboptimal design, without tracking phase difference, shows improvement by a factor up to about 15 over the threshold receiver. The non-adaptive design, basically of optimal <u>structure</u>, but premised on interference-free reception, shows approximately equivalent performance as the threshold receiver.

Tables 3.2 thru 3.12 give the full results of the OPTRVR and SUBOPT simulation runs associated with Figures 3.3 thru 3.7 -- error statistics for each coordinate of the state estimate as a function of θ_{sep} . One observation that can be made from this data is that the mean error at small separation angles becomes a more significant contributor to the RMSE as the S/N diminishes. This probably signals a diminishing validity of the LOE criterion (error being in a neighborhood of zero), due

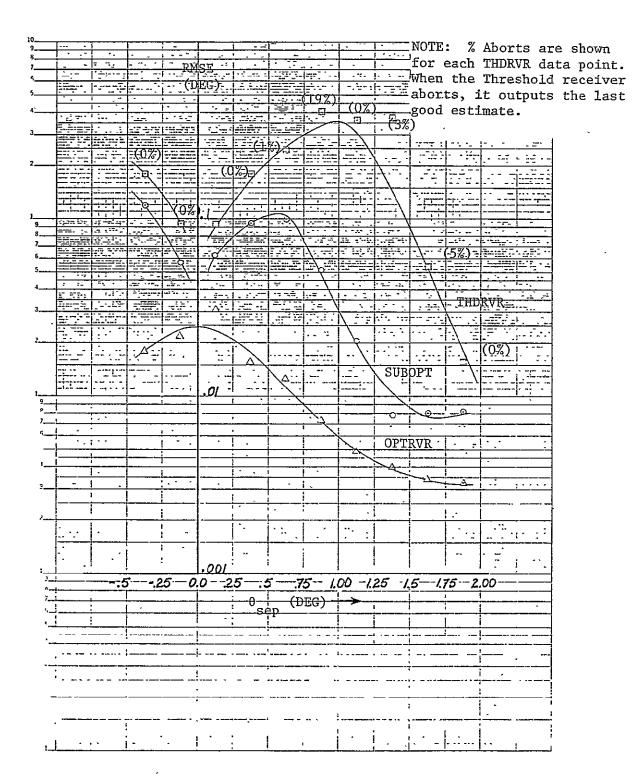


Figure 3.5 RMSE (θ_{sep}), comparison of receivers, S/N=30 db, ρ =0.8

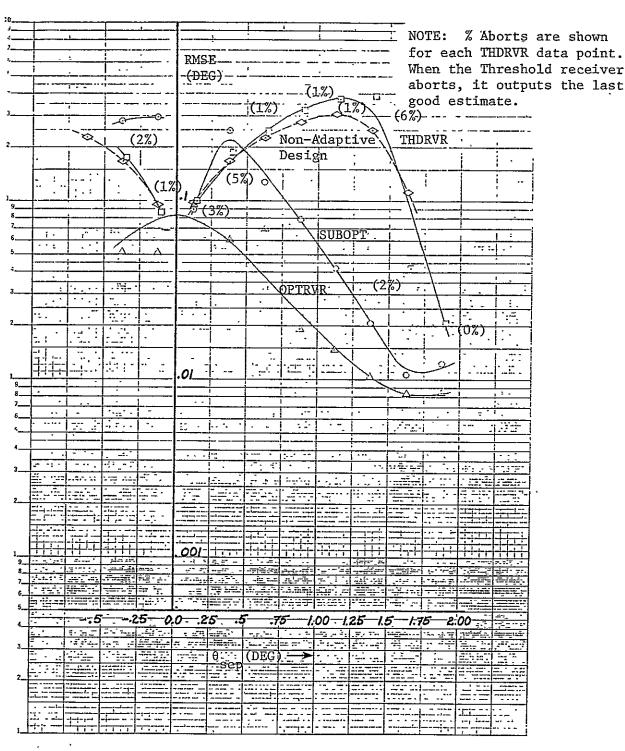


Figure 3.6 RMSE (θ_{sep}), comparison of receivers, S/N=20db, ρ =0.8

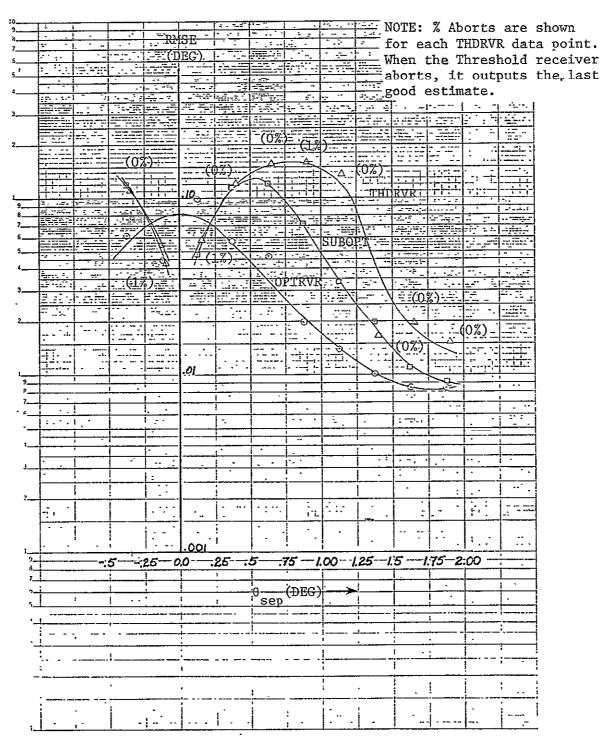


Figure 3.7 RMSE (θ_{sep}) , comparison of receivers S/N = 20 db, $\rho = 0.5$

ÝΤΥ	THESEP	ALFA	THETA	THEOOT	ALFAR	THETAR	THROOT	В	· wsc
¿MEAN:	375	-1.43	286E-02	•146E-02	-1.07	.260E-02	163E-02	272E-01	441E-01
	125	-3.82	292E-02	.649E-03	12.1	164E-01	200E-02	.378E-01	233
	.125	1.25	228È-02	102E-02	8.26	.105E-01	.144E-02	.603E-01	369
	·• 375	581	.144E-02	•112E-02	-2.27	626E-02	218E-02	208E-G1	154E-01
	•625	 28℃	.149E-02	.990E-03	609	339E-02	1716-02	186E-01	269E-02
	. 675	.257E-01	118E-04	.451E-04	774E-01	731E-03	414E-03	464E-02	176E-02
	1.13	•254e - úl	137E-03	145E-03	.562E-02	344E-04	929E-04	.231E-03	.190E-02
	1.38	.215è-61	138E-03	493E-04	.107E-01	.127E-05	231E-03	.191E-02	566E-01
	1.03	.150E-01	734E-04	134E-04	.120E-01	141E-05	310E-03	.123E-C2	.930E-02
	1.88	•103E-01	•586E-04	•938E-04	•144E-01	•304E-05	312E-03	•583E-03	413E-01
ERMS :	375	4.12	.846E-02	•236E-01	4 • 15	.113E-01	•295E-01	.678E-01	•438
	125	12.7	•998E-02	.2U9E-01	15.0	•209E-01	.269E-01	•163	.857
	• 125	1ù.9	•956E-02	.208E-01	13.9	.188E-01	.280E-01	.181	. •948
	• 375	3.67	•793E - 02	.237E-01	3.87	.105E-01	.244E-01	489E-01	•437
	•625	1.13	.492E-02	.223E-01	1.18	.638E-02	•212E-01	. 407E+01	•348
	875	•441	•276£-02	•172E-01	• 456	•358E-02	•193E-01	.224E-01	.241
•	1.13	247	.188E-02	.152E-C1	. 4232	•233E-02	.167E-01	.251E-01	· 259
	1.38	.103	•154E-02	•148E-01	.184	.186E-02	•154E-01	.234E-01	.429
	1.63	.161	•132E-02	•142E-01	174	•162E~02	•157E-01	•313E-01	• 357
	1.88	.161	•125ē - 02	.137E-01	.177	•145E-02	•152E-01	.391E-C1	•474
ESTD:	375	3.87	•796E-0.2	•236E-01	4.01	.110E-01	.294E-01	.622E-01	•435
	125	12.1	•954E-02	.209E-01	8.79	•1306-01	.268E-01	158	• 8 2 5 ·
	•125	10.6	•928E-02	.207E-01	11.2	.157E-01	.280E-01	•171	·873
	• 375	3.63	.780E-02	.237E-01		.840E-02	.243E-01	. 443E-01	.437
	•625	1.10	•469E-02	.223E-01	1.01	.540E-02	.212E-01	.362E-C1	•348
	• e 75	•44U	.276E-02	•172E-G1	•449	•350E-02	.193E-01	.219E-01	•241
	1.13	.246	•188E-J2	.152E-01	• 232	.232E-02	.167E-01	.251E-01	• 259
	1.38	.182	•153E-02	.148E-01	.184	•186E-02	•154E-01	.233E-01	· 425
	1.63	.161	.132E-02	.142E-01	•174	.162E-02	.157E-01	.312E-01	.357
	1.88	•161	•124E-02	•137E-01	.177	•145E-02	•152E-01	+391E-01	•473

Table 3.2 Error Statistics vs θ_{sep} , OPTRVR, S/N=40db, ρ =0.8

QTY	THESEP	ALFA	THETA	THEDOT	ALFAR	THETAR	THROOT	В	WSC
EMEAN:	375	975	186E-02	.126E-02	-1.49	•528E-02	223E-02	319E-01	348E-01
	125	-5.19	391E-02	.170E-02	13.9	348E-01	584E-02	•521E-03	256
	•125	-5.23	.133E-02	686E-02	17.5	.555E-01	.1638-01	•592E-01	-1.61
	.375	689	.153E-02	-137E-02	-2.22	950E-02	211E-02	274E-01	192E-01
	•625	117	.829E-03	•894E−Ó3	634	560E-02	223E-02	190E-01	.302E-02
	• b 75	.3l∪£-ù1	188E-C4	.660E-04	649E-01	927E-03	723E-03	663E-02	936E-02
	1.13	.154t-Ul	778E-04	563E-04	.934E-02	.208E-03	318E-03	•683E-03	635E-01
	1.36	•202E-61	1198-03	163E-04	.706E-02	.578E-04	456E-03	•101E-02	746E-01
	1.63	.156E-01	740E-04	.460E-04	.843E-02	.658E-04	503E-03.	•107E+01	644E-01
	1.88	.108E-01	•526E-04	.557E-04	•102E-01	.508E-04	455E-03	•374E-02	447E-01
ERMS:	375	4.11	.820E-02	.221E-01	4.37	.183E-01	•354E-01	.796E-01	•482
	125	14.5	.111E-01	•199E-01	16,6	.415E-01	.346E-01	•174	•818
	•125	21.6	.202E-01	.278E-01	24.4	.831E-01	.669E-01	•513	4.82
	.375	3.44	•721E-02	.218E-01	3.97	.169E-01	.305E-01	•585E-01	•430`
	•025	1.09	.434E-J2	.199E-01	1.29	.110E-01	.270E-01	•389E-01	•306
	.875	•404 °	.2628-02	.168E-01	• 449	•548E-02	.218E-01	•315E-01	•311
	1.13	•241	•187E-02	.153E-01	.243	.371E-02	•190E-01	•370E-01	• 404
	1.38	-160	•152E-02	.147E-01	·187	.281E-G2	.179E-01	•292E-01	•512
	1.63	. 161	•132E-02	.142E-01	•177	•242E-02	•179E-01	•430E-01	• 473
	1.88	•160	-124E-02	•136E-01	• 179	•219E-02	•176E-01	.414E-01	•522
ESTD:	375	3.99	.7998-02	.221E-01	4.11	.176E-01	.353E-01	.729E-01	-481
	125	13.6	.104E-01	•198E-01	9.19	.226E-01	.341E-01	•174	•777
	•125	20.9	.202E-01	.269E-01	16.9	.618E-C1	.649E-01	•510	4.54
	.375	3.37	.705E-0⁄Z	.217E-01	3.29	.139E-01	.304E-01	•516E-01	• 4 2 9
	.625	1.68	.426E-02	.199E-01	1.12	•951E-02	.269E-01	.339E-01	.306
	• t75	• 462	.262E-02	.168E-01	.444	.540E-02	.218E-01	•308E-61	•311 ′
	1.13	.240	.186E-C2	•153E-01	·243	.370E-02	•190E-01	.370E-01	•399
	1.38	•179	·152E-02	.147E-01	.187	.281E-02	.179E-01	.292E-01	• 506
	1.63	.166	•132£-J2	.142E-01	.177	•242E-02	.179E-01	.417E-01	-468
	1.88	.160	•123E-02	•136E-01	.178	•219E-02	•176E-01	•413E-01	•520

Table 3.3 Error Statistics vs θ_{sep} , OPTRVR, S/N=40db, ρ =0.5

QTY	THESEP	ALFA	THETA	THEDOT	ALFAR	THETAR	THROOT	В	WSC
EMEAN:	375	-1.29	740E-02	•943E-03	876	•446E-02	117E-02	695E-01	145
	125	-4.30	855E-02	.388E-02	9.89	598E-01	931E-02	.441E-C1	324
	.125	6.01	225E-01	342E-02	-1.29	358E-02	.357E-02	.612E-01	214
	• 375	- .670	•364E-02	•991E-03	-1,40	114E-01	873E-03	569E-01	126
	.625	163	.228E-02	•997E-03	 368	534E-02	217E-02	391E+01	902E-02
	•875	.346E-01	959E-03	·110E-02	3026-01	988E-04	181E-02	.119E-01	640E-01
	1.13	.260£-01	932E-03	•499E-03	.264E-02	.407E-03	759E-03	.128E-01	133
	1.38	•147E-01	666E-03	.499E-03	.466E-02	.535E-03	743E-03	.827E-02	158
	1.63	•599E - 02	361E-03	•461E-03	.232E-02	.425E-03	804E-03	.963E-02	222
	1.88	263E-03	•727E-04	•204E=G3	•111£-02	•191E-03	504E-03	•132E-01	259
ERMS:	375	2.79	•179E-01	.301E-01	2.82	•237E=01	•358E-01	•145	•647
	125	9.81	.216E-01	.237E-01	11.3	.720E-01	.316E-01	.234	.864
	•125	7.00	.310E-01	.264E-01	5.70	.224E-01	.291E-01	.205	.715
	.375	2.32	•157£-01	.3u6t-01	2.60	.214E-C1	.309E-01	.127	. 675
•	.625	•956	.125E-01	.322E-01	1.01	.166E-01	.3162-01	.136	.517
	• と 7う	• 37d	•7262 - 02	.231t-01	.371	.845E-02	.241E-C1	.633L+01	.510
•	1.13	• 2 2 8	.493E-02	.2∪4E-01	.222	.617E-02	.218E-J1	•596£-Cİ	.505
	1.30	•175	.398E-02	.202E-G1	.183	•457E-C2	.200E=01	•541E+6 1	.715
	1.63	.159	•340£ - C2	.2C1E-01	.174	.4116-02	•267E-01	•743E-61	• 776
	1.08	•160	•326E-02	.200E-01	• 177	.3708-02	.202E-61	•115	• t 73
£STD:	375	2.47	•1o3E=01	•301£-01	2.68	.2336-01	.358E-01	.127	.631
	125	Ե∙ 82	.198E-01	•234E-01	5.55	•402E-01	.3626-01	.23)	• E :-1
	•125	3.60	.213E-01	•262E-u1	5.55	.221E-01	.289E-01	.195	•683
	.375	2.23	•153E-ol	•306E-01	2.19	•181£-01	.308E-01	.114	• 663
	• 655	•942	•123E-01	.3226-01	• 444	.157E-ul	. 369E+61	•485E - Cl	•517
	•07⊃	•376	•726E-02	.2316-01	•370	.845E-02	.240E-01	.622E+C1	. EOE
	1.13	.227	•484E-02	.204E-01	.222	.615E-62	.218E-01	.582E-01	• 570
	1.38	•174	.393E-02	.202E-01	•183	•453E-02	.200E-01	.535E-C1	•697
	1.63	.159	.338E-02	.2015-01	.174	.409E-02	.207E-01	.734E-01	•743
	1.88	•160	•326E-02	•200E-01	.177	•370E-02	•202E-01	•114	.833

Table 3.4 Error Statistics vs θ_{sep} , OPTRVR, S/N=30db, ρ =0.8

	QTY	THESEP	ALFA	THETA	THEDOT	ALFAR	THETAR	THROOT	В	WSC
	EMEAN:	375	483	214E-02	.214E-02	428	250E-02	733E-02	638E-01	~.143
		125	-1.06	.182E-02	.404E-02	7.02	673E-01	887E-02	•919E-01	453
		•125	5.74	3886-01	863E-02	773	5228-01	350E-01	.183	165 .
		.375	.375	247E-02	.252E-03	-1.43	173E-01	.239E-J2	517E-01	186
		.625	.470E-01	3638-03	.656E-03	263	445E-02	949E-03	192E-01	7498-01
		.875	.162E-01	500E-03	.964E-03	•139E-01	.213E-02	2438-02	.873E-02	725E-01
		1.13	.138E-01	573E-03	.767E-U3	2398-02	.112E-02	143E-02	.909E-02	198
		1.38	•143E-01	617E-03	.482E-03	•219E-03	.158E-02	109E-02	•932E-02	185
		1.63	.641E-02	343E+03	.292E-03	613E-02	•105E-02	169E-02	•150E~01	314
		1.88	•711E-03	.383E-04	•128E-03	801E-02	•293E-03	293E-03	.2308-01	300
	ERMS:	375	2.40	.169E-01	.277E-01	2.68	•420E-01	•474E-01	•174	.757
		125	7.58	.235E-01	.302E-01	7.75	.770E-01	.300E-01	•422	1.12
		.125	7.83	.582E-01	•331E-01	5.08	.110	.748E-01	•444	.876
		.375	2.05	.145E-01	.276E-01	2.55	.329E-01	.353E-01	•146	.733
		.625	.892	.108E-01	.290E-01	1.05	.275E-01	•415E-01	•100	•611
		.875	•359	.694E-02	.229E-01	• 3 6 3	.141E-01	.292E-01	•585 E-01	•560
		1.13	.223	.498E-02	.207E-01	• 229	•994E-02	.255E-01	.632E-01	•756
		1.38	•173	•383E-02	.198E-01	- + 186	•697E-02	.228E-01	.619E-01	•747
		1.63	•158	.338E-02	.200E-01	•176	•625E-02	.239E-01	.939E-C1	•915
71		1.88	.159	•326E-02	.200E-01	•178	•550E-02	.226E-01	.999E-01	. 92.6
;	ESTD:	375	2.35	.168E-01	.276E-01	2.65	.419E-01	.468E-01	.162	•743
		125	7.51	.234E-01	.300E-01	3.30	•374E-01	.286E-01	•412	1.03
		•125	5.32	.433E-01	•320E-01	5.02	.963E-01	•661E-01	•405	.860
		.375	2.01	.143E-01	.276E-01	2.11	.260E-01	.353E-01	.137	•709
		•625	.891	.108E-01	.290E-01	1.02	.271E-01	.415E-01	.986E-01	•606
		.875	•359	.692E-02	.229E-01	• 383	•140E+01	.291E-01	.578E-01	•555
		1.13	.223	.495E-02	.207E-01	•229	.987E-02	.255E-01	.626E-01	•730
		1.38	•172	.378E-02	.198E-01	•186	•679E-02	.228E-01	.612E-01	• 724
		1.63	.158	.337E-02	.200E-01	•176	•616E-02	.239E-01	.927E-01	• 8 6 0
		1.88	.159	•326E-02	.200E-01	.178	•549E+02	.226E-01	.972E-01	.876

Table 3.5 Error Statistics vs θ_{sep} , OPTRVR, S/N=30db, ρ =0.5

QTY	THESEP	ALFA	THETA	THEDOT	ALFAR	THETAR	THROOT	В	WSC
EME AN:	375	•514	.269E-01	.108E-01	1.17	586E-01	197E-01	•727E-01	323
	125	•256	.247E-01	.140E-01	3.47	100	200E-01	.220	499
	•125	3.20	747E-G1	174E-01	1.09	.738E-02	112E-02	•484	450
	• 375	1.41	451E-01	131E-01	• 499	.262E-01	•177E-01	.119	325
	• 625	662	459E-01	.204E-02	.841	.786E-01	•142E-02	•389	516
	.875	•106	963E-02	.606E-03	.420E-01	.867E-02	.292E-03	.330E-01	296
	1.13	.259E-01	543E-02	.229E-02	128E-C1	•398E-02	231E-02	.332E-01	376
	1.38	139E-02	318E-02	•165E-02	155E-01	•439E-02	127E-02	.364E-01	378
	1.63	164E-C1	15CE-02	.102E-02	262E-01	•313E-02	461E-03	.485E-C1	523
	1.08	256E-01	•324E-03	•706E-03	316E-01	•504E-04	428E-03	.638E-01	610
ERMS:	375	1.62	.521E-01	.330E-01	1.70	.783E-01	.385E-01	•312	.964
	125	3.55	.515E-01	•345E-01	3.83	•119	•342E+01	•612	1.16
	•125	3.86	•958E-01	.433E-01	2.63	-366E-01	.385E-01	• 595	1.09
	.375	1.76	.596E-01	•375E-01	1.51	.603E-01	.416E-01	-245	835
	•625	1.05	.686E-01	.683E-01	1.25	.113	•964E-01	.647	1.13
	.875	.307	•191E-01	.259E-01	•320	.247E-01	.364E-01	.170	•926
	1.13	.212	•148E-01	.281E-01	.219	•192E+01	•344E-01	.139	.869
	1.38	.165	•102E-01	•256E-01	•181	•126E-01	.260E-01	•118	.821
	1.63	•156	.848E-02	.257E-01	.175	•111E-01	.281E-01	•146	1.12
	1.88	.159	.845E-02	.267E-01	• 177	•968E-02	.269E-01	.228	1.27
ESTD:	375	1.54	.446E-01	•312E-01	1.23	•519E-01	•331E-01	•303	.908
	~. 125	3.54	•451E-C1	•315E-01	1.62	.635E-01	.277E-01	•571	1.04
	•125	2.16	.600E-01	.396E-01	2.40	.358E-01	.385E-01	•346	. 992
	.375	1.04	•391E-01	•351E-01	1.43	•543E-01	.377E-01	.215	.769
	•625	•812	•510E-01	.683E-01	• 924	.805E-01	.964E-01	•517	1.00
	.875	•288	•165E-01	.2598-01	•318	•231E-01	.364E-01	.167	.878
	1.13	.211	•137E-01	.280E-01	.219	.188E-01	•343E-01	.135	.783
	1.38	.165	•974E-02	•255E-01	.181	.118E-01	.260E-01	.112	.729
	1.63	155	.835E-02	.257E-01	•173	.106E-01	.281E-01	.137	.994
	1.88.	.157	•844E-02	.267E-01	•174	•968E-02	.269E-01	•219	1.12

Table 3.6 Error Statistics vs θ , OPTRVR, S/N=20db, ρ =0.8

OTY	THESEP	ALFA	THETA	THEDOT	ALFAR	THETAR	THROOT	8	· WSC
EMEAN:	375	•746	•373E-01	•173E-01	1.23	137	478E-01	•175	501
	125	•777	•291Ł-01	.107F-01	2.06	724E-01	285E-02	.323	468
	.125	2.80	670E-01	1598-01	•739	1438-01	224E-01	•922	304
	• 375	1.19	405E-01	588E-02	•164	•194E-01	.189E-01	•182	535
	•625	.369E-01	148E-01	169E-02	1,16	•163	•164E-01	• 352	586
	.875	.125	120E-01	143t-02	•133	•327E-01	•440E-02	•131	318
	1.13	.203E-01	469E-02	•251E-02	226E-01	.868E-02	- .277E-02	•379E-01	433
	1.38	3616-02	269E-02	.151E-62	3326-01	•744E-02	~. 2458-02	•506E-01	495
	1.63	157E-01	146E-02	•247E-03	479E-01	•520E - 02	809E-03	•717E-01	659
	. 1.88	242 E-01	•179E-03	.698E-03	502E-01	.408E-03	321E-03	•784E-01	667
ERMS:	-+375	1.58	-619E-01	.409E-01	1.79	•191	.665E-01	•423	1.19
	125	2.41	.446E-01	.308E-01	2 • 45	.938E-01	•365E -01	.644	1.04
	•125	4.05	.987E-01	.477E-01	1.30	.864E-01	.621E+01	1.32	•920
	• 375	1.68	.5778-61	.430E-01	1.34	.769E-01	•547E-01	.312	1.18
	• 625	1.00	.465E-01	•564E-01	1.30	•186	.897E-01	•504	1.19
	. 675	·280	•195E-01	•284E+01	• 309	.429E-01	.360E-01	.215	.863
	1.13	.201	•140E-01	.267E-01	•221	.315E-01	.442E-01	•148	•908
	1.38	•166	.101E-01	.254E−G1	•187	.215E-01	•338E-01	.151	1.07
	1.63	.155	•642E-02	•252E-01	•182	•164E-01	.321E-01	•1 95	1.33
	1.88	•158	.842E-02	·264E-01	• 182	•154E-01	.325E-01	.277	1.27
ESTD:	375	1.39	.495E-01	•371E-01	1.30	.133	.462E-01	.385	1.08
	125	. 2•28	.337E-01	.289E-01	1.33	•596E-01	.364E-01	•557	•934
	.125	2.43	.724E-01	•450E-01	1.07	.852E-01	•579E-01	•942	.869
	• 375	1.19	•411E-01	•426E-01	1.33	•744E-01	•514E-01	.254	1.05
	•62 <u>5</u>	1.00	.441E-01	•564E-01	.580	.888E-01	.882E-01	.361	1.03
	• 875	.250	.154L-01	.283E-01	•279	.278E-01	•357E-01	•171	.802
	1.13	.200	.132E-01	.266E-01	•220	•303E-01	•441E-01	.144	•798
	1.38	•166	.974E-02	.253E-01	•184	.201E-01	•337E-01	•142	•945
	i.63	• 155	.830E-02	.252E-01	•176	.155E-01	.321E-01	.181	1.15
	1.88	•156	.842E-02	.264E-01	•175	·154E-01	·325E-01	+266	1.08

Table 3.7 Error Statistics vs $\theta_{\mbox{\footnotesize sep}},$ OPTRVR, S/N=20db, $\rho = 0.5$

OTY

THESEP

ALFA

THETA

THEODT

ALFAR

THETAR

THROOT

WSC

Table 3.8 Error Statistics vs θ_{sep} , OPTRVR, S/N=14 db, ρ =0.8

OTY	THESEP	ALFA	THETA	TOOSHT	ALFAR	THETAR	THROOT	8	WSC
EMEAN:	375	.674	.756r-01	.226E-01	• 444	147	514E-01	•358	807
	125	.803	.570E-01	.141E-01	.872	813E-01	140F-01	.838	210
	.125	1.50	158	5776-01	· 248	168E-01	195E-01	.716	-1.28
	.375	1.64	168	4316-01	149	136	561E-01	.784	863
	. 625	.221	468E-01	112F-01	•611	•179	.440E-01	.477	889
	.875	.128	293E-01	138E-02	.104	.661E-01	.837E-02	.225	824
	1.13	.801E-02	126E-01	•323E-02	198E-01	.280E-01	214E-03	.125	760
	1.38	299E-C1	4935-02	.305E-02	579E-01	•125E-01	581E-02	.124	666
	1.63	429E-C1	113t-02	.121E-02	651E-01	.894E-02	294E-02	.108	815
	1.88	÷.465E-01	.2006-02	•323E-03	668E-01	•313E-02	696E-03	•124	-1.03
EPMS:	375	•966	.975E-01	.506E-01	•906	• 228 .	.864E-01	•630	1.46
•	125	1.36	.872E-01	•386E-01	1.17	•130	•505E-01	1.21	.848
	•125	2.23	.258	•985E-01	•939	•152	.815E-01	•990	3.48
	• 375	2.19	-263	.116	•747	.231	•990E~01 .	1.21	1.48
	•625	.788	.917E-01	.784E-01	•751	.220	•108	•723	1.51
	.875	.264	.4566-01	443E-01	.302	.103	•757E-01	•431	1.43
	1.13	.194	.305E-01	.382E-01	.210	.683E-01	•697E-01	•314	1.29
	1.38	.161	.206b-01	.335E-01	.185	.493E-01	•569E-01	.309	1.23
	1.63	•154	.155E-01	•310E-01	•186	.323E-01	.423E-01	.346	1.39
	1.88	.157	.1598-01	.333E-01	•186	.298E-01	•433E-01	•522	1,•76
ESTD:	375	•692	.615E-01	.453E-01	.789	•175	.695E-01	•518	1.21
	125	1.10	•660E-01	.359E-01	•774	.101	.486E-01	•869	.821
	.125	1.65	.203	-798E-01	• 905	.151	.791E-01	•684	3.23
	• 375	1.46	.201	.168	.732	. 187	.816E-01	•915	1.20
	•625	•756	.789E-01	.776E-01	•436	.128	•986E-01	•542	1.22
	• 875	.253	.350E-01	•443E-01	.283	•790E-01	.752E-01	•368	1.16
	1.13	•194	.277E-01	.381E-01	.209	•623E-01	•697E-01	.288	1.04
	1.38	•158	.200E-01	.333E-01	.176	•477E-01	.566E-01	.283	1.04
	1.63	.148	.155E-01	.309E-01	•174	.311E-01	.422E-01	. •329	1.13
	1.88	.149	.157E-01	.333E-01	•173	.296E-01	•433E-01	•508	1.43

Table 3.9 Error Statistics vs θ_{sep} , OPTRVR, S/N=14db, ρ =0.5

OTY	THESEP	ALFA	THETA	THEDOT	ALFAR	THETAR	THROOT
FWEWN:	375	-11.9	101	•234E-02	3.80	305E-01	918E-02
	125	-9.05	375E-01	.955E-02	17.1	971E-01	417E-01
	.125	-9.53	.271E-01	175E-01	13.7	.415E-01	.704E-01
	• 375	-9.52	.795E-01	793E-03	5.77	•531E-01	•447E-02
	•625	-2.01	.192E-01	178E-01	•767 ·	.402E-01	.188E-01
	875	•310	332E-02	399E-02	•328	.748E-02	•611E-02
	1.13	• 222	486E-02	100E-02	.225	.673E-02	.576E-03
	1.38	.630E-01	113E-02	.233E-03	.570E-01	.200E-02	632E-03
	1.63	299E-01	•753E-03	.201E-03	•375E-02	642E-03	617E-03
	1.88	1666-01	•911E-03	•149E-03	529E-02	114E-02	391E-0.3
ERMS:	375	16.0	•119	•200	5.01	.863E-01	•189 ·
	125	15.1	.562E-01	.100E+00	18.3	.201	.246
	•125	16.9	.624E-01	•119	16.4	•153	•255
	.375	11.5	.945E-01	•762E-01	6.66	•102	•146
	•625	6.51	•990E+01	•749E-01	4.97	•116	. 108
	.875	1.76	.518E-01	•595E-01	2.23	.789E-01	.861E-01
	1.13	•705	.206E-01	•522E-01	•686	•227E-01	.497E-01
	1.38	•372	.787E-02	.236E-01	•4 0 8	•972E-02	.276E-01
	1.63	.271	.801E-02	•193E-01	.310	•116E-01	.271E-01
	1.88	.191	.820E-02	•184E-01	•199	•108E-01	•224E-01
ESTD:	375	10.7	.629E-01	.200	3.26	.807E-01	.188
	125	12.1	•419E-01	•995E-01	6 • 6 4	•176	• 242
	•125	14.0	•563E-01	•118	8.95	.147	.245
	.375	6.54	.510E-01	.762E-01	3.32	.873E-01	.146
	•625	6.19	•971E-01	.728E-01	4.91	.109	•107
	• 875	1.73	•517E-01	•594E-01	2.20	.785E-01	.859E-01
	1.13	•669	.200E-01	•522E-01	•648	.217E-01	•497E+01
	1.38	•366	•779E-02	.236E-01	• 404	•952E-02	.276E-01
	, 1.63	•269	.798E-02	•193E-01	.310	.116E-01	.271E-01
	1.88.	.190	.815E-02	.184E-01	. 199	.108E-01	•224E-01

Table 3.10 Error Statistics vs θ_{sep}^{-} , SUBOPT, S/N=30db, ρ =0.8

QTY	THESEP	ALFA	THETA	THEOOT	ALFAR	THETAR	THROOT
EME AN:	375	4.73	.254	.389b-01	802	332E-01	755E-01
	125	5.61	280	464E-01	 568	•198	•421E-01
	.125	-1.55	207E-03	301E-01	7.03	•577	.102
	•375	4.06	215	338E-01	105	•488E -01	.734E-01
	•625	260	182E-01	286E-01	2.81	•233	•377E-01
	• 8 7 5	•432	 392E-01	112E-01	• 8 79	.905E-01	.157E-01
	1.13	• 244	240E-01	259E-02	• Ż28	:326E-01	.416E-02
	1.38	•388 ± -01	686E-02	•618E ~0 3	.300E-01	.106E-01	•114E-03
	1.63	291E-01	•990E - 03	•129E-02	308E-01	.209E-02	950E-03
	1.88	341E-01	.289E-02	.985E-03	429E-01	273E-02	964E-03
ERMS:	375	4.81	•280	.169	3.52	.200	.181
	125	5.94	• 294	•109	3.75	•210	•749E-01
	.125	5.45	.895E-01	•969E -01	7.07	•640	
	•375	4.29	• 248	•149	2.94	.188	•178
	.625	2.43	.128	.114	.2.89	•249	•106
	• 875	•920	•791E-01	•666E -01	1.00	•116	•862E-01
	1.13	• 349	.416E-01	.391E-01	• 356	.623E-01	•605E-01
	1.30	.178	.202E-01	.305E-01	• 195	.273E-01	•369E-01
	1.63	.174	.108E-01	.267E-01	.213	•143E-01	•318E-01
	1.88	•171	•121E-01	.263E-01	• 203	•171E-01	.289E-C1
ESTD:	375	•679	.117	•165	3.43	•197	•164
	125	1.93	.908E-01	•986E -01	3.70	.711E-01	.619E-01
	•125	5.23	.895E-01	•921E-01	•762	• 276	.137
	• 375	1.38	•123	•145	2.94	•182	.163
	•625	2.42	.127	.110	•661	.879E-01	.985E-01
	675	.813	.687E-01	.657E-01	•478	•732E-01	.847E-01
	1.13	·250	.340E-01	. 4390E-01	•274	.531E-01	.604E-01
	1.38	•174	.190E-01	.305E-01	.193	.252E-01	.369E-01
	1.63	•171	.107E-01	.267E-01	•211·	.141E-01	.318E-01
	1.88	•167	.117E-01	.263E-01	•198	.169E-01	.289E-01

Table 3.11 Error Statistics vs $\theta_{\text{sep}}^{\parallel}$, SUBOPT, S/N=20db, ρ =0.8

QTY	THESEP	ALFA	THETA	THEDOT	ALFAR	THETAR	THROOT
EMEAN:	375	 743	848E-Q2	.260E-01	3.90	811	165
	125	712	.118E-02	.155E-01	4.43	245	361E-01
	.125	690	.247E-02	122E-01	4.48	.380	•781E-01
	• 375	743	•137E-01	245E-01	3.99	842	•152
	•625	547	.118E-u1	194E-01	2.58	•418	•659E-01
	•875	.150E-01	1085-01	868E-02	1.00	•178	.308E-01
	1.13	.112	135E-01	199E-G2	.252	•653E-01	•111E-01
	1.38	•179E-01	462E-C2	.781E-03	.258E-01	•216E-01	•161E=01
	1.63	294E-01	1'97E-02	.103E-02	432E-01	•648E-02	168E-02
	1.88	2926-01	-290E-02	.953E-03	622E-01	281E-02	302E-02
ERMS:	176	2 05					•••••
EKNSI	375	3.05	•119	•100	3.93	.868	.271
	125	3.43	.553E-01	•552E-01	4 . 45	• 305	.849E-01
	.125	3.44	.480E-01	.491E-01	4.50	• 4 4 4	.102
	• 375	3.05	•114	•963E-01	4.02	•901	.274
	•625	2.28	•121	.100	2.63	•422	.143
	.875	•948	•718E-01	•635E - 01	1.03	•201	.123
	1.13	.336	•372E-01	•367E-01	• 352	•106	•964E-01
	1.38	•170	•196E - 01	.286E-01	•192	•500E-01	.569E-01
	1.63	•154	•112E-01	.264E-01	•215	-210E-01	.369E-01
	1.88	•156	•917E-02	•254E-01	.210	.285E-01	.370E-01
ESTD:	375	2.96	•119	•966E-01	•497	•311	• 215
	125	3.35	.553E-C1	.530E-01	.431	.182	•769E -01
	.125	3.37	.479E-01	476E-01	•409	•229	•656E-01
	.375	2.96	•113	•931E-C1	•512	•322	•228
	•625	2.21	•120	.983E-01	.495	.561E-01	.127
	.875	•947	.710E-01	.629E-01	.258	•937E-01	.120
	1.13	.317	.346E-01	.366E-01	.246	.841E-01	•958E-01
	1.38	•169	•191E-01	-286E-01	•190	454E-01	•568E-01
	1.03	.151	.110E-01	.264E-01	210		•369E=01
	1.88	•153	.870E-02	.254E-01	•201	•284E-01	•369E-01

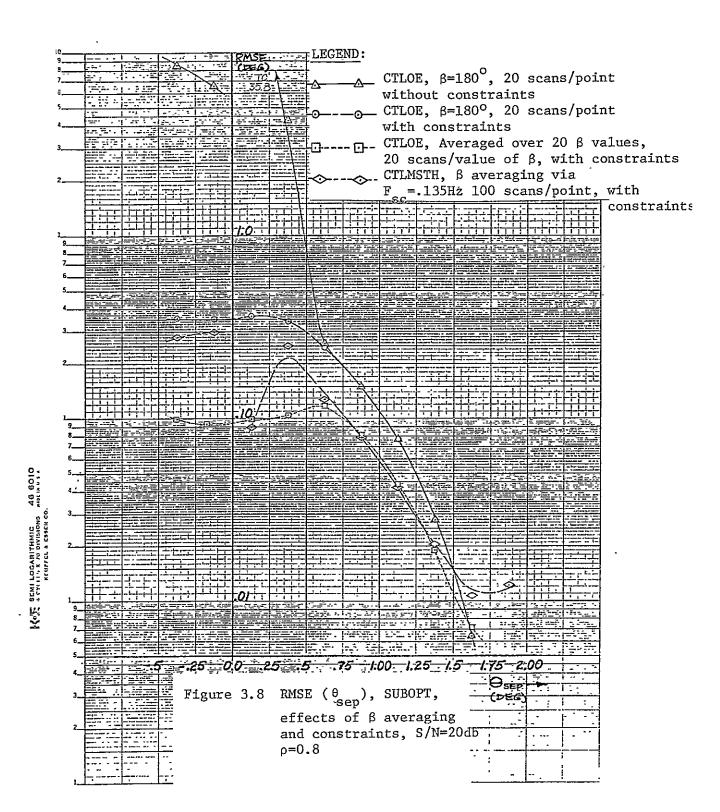
Table 3.12 Error Statistics vs θ_{sep} , SUBOPT, S/N=20db, ρ =0.5

in part to the relatively large value of GQGT (8.8) used, $\[\[\] (2.7r/s)^2 \]$ (in AZ). This value was selected to facilitate tracking a varying $\[\] w_{sc}$ under the condition that it is changing at the maximum rate at which it can be tracked in the present structure, based on angle function rep. rate considerations (recall (3.135)) (i.e. without extracting its derivative and integrating (as in the 6D LOE design)). This was a practical consideration that penalized some the performance in the steady state (when $\[\] w_{sc}$ was not changing).

Figure 3.8 summarizes a study of the SUBOPT receiver; it shows that

- 1. In the worst cast wrt β , i.e. β =180°, the constraints on the estimate helped for small θ and did not influence the performance for larger θ and that
- 2. Averaging over noise effects and β simultaneously by using a small non-zero $\dot{\beta}$ (= ω_{SC}) to sweep β over a 2π interval seems adequate generally, with some error possibly arising for small θ_{SEP} . This method of averaging over β was used generally.

Figure 3.9 and Tables 3.13 thru 3.16 following show the effects of a form of mismatch between the receiver design and its signal environment, specifically a mismatch in the presumed and actual values of the transmitting antenna beamwidth, (given the antenna selectivity functions, p, p_{MLS} , are otherwise identical). Much can be said about the necessity of tuning a high-performance signal processor to its signal environment, but the manifest RMSE sensitivity here to B_{RCVR}/B_{MLS} is nevertheless striking. The tables provide some insight, for example



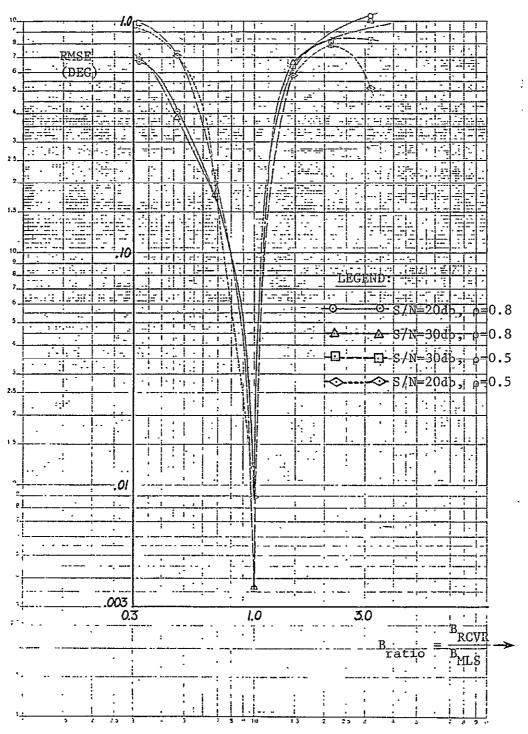


Figure 3.9 RMSE (B_{RCVR}/B_{MLS}), OPTRVR, θ_{sep} =1.5°

OTY	BRATIO	ALFA	THETA	THEDOT	ALFAR	THETAR	THPDOT	8	WSC
EMEAN:	•316	-3.75	553	130	-4.76	•721F-01	•335E-01	.734E-01	-20.6
	• 464	-2.47	345	599E-01	-3.20	.252	•101	•598	-16.6
	•681	-1.27	151	221E-01	-1.67	.906E-01	.382E-01	. 662	-5.05
	1.00	961E-02	234E-02	.127E-02	210E-01	•392E-02	110E-02	.390Ė -0 1	456
	1.47	-49.2	•636	•646E-01	-49.5	687	748E+01	-1.43	.728
	2.15	-6.92	•798	.774E-01	-1.24	-,422	118	-1.11	289
	3.16	.587	1.13	•170	4.94	1.11	•189	-1.14	-2.90
ERMS:	•316	5.87	•676 `	• 463	7.39	.208	•352	1.18	24.1
	• 464	3.49	•409	•337	4.82 .	.474	•452	1.08	19.7
	.681	1.48	.177	•114	2.16	•225	•196	1.06	6.29
	1.60	•158	•915E-02	.257E-01	•177	•114E-01	.261E-01	.124	.931
	1.47	55.2	.638	•171	55.5	•689	.186	1.68	.746
	2.15	8.25	.817	.235	4.35	•492	.156	1.81	1.33
	3.16	1.79	1.16	.317	5.15	1.48	•421	1.67	3.51
ESTD:	•316	4.51	.389	•445	5.65	•196	•351	1.18	12.5
	•464	2.47	-218	•331	3.60	•402	.441	. 896	10.6
	.681	•768	.922E-01	•112	1.38	.206	.193	.823	.3.75
	1.00	•158	.885E-02	.257E-01	.176	.1C7E-01	.261E-01	•118	.812
	1.47	24.8	.467E-01	.158	25.0	.538E+01	•171	.883	-161
	2.15	4.48	.174	•222	4.17	• 252	.101	1.42	1.29
	3.16	1.69	.266	•267	1.43	•979	•376	1.21	1.98

Table 3.13 Error Statistics vs B_{ratio} , OPTRVR, S/N=20db, ρ =0.8, θ_{sep} =1.5°

QTY	BRATIO	ALFA	THETA	THEDOT	ALFAR	THETAR	THROOT	В	MSC
EMEAN:	•316	-11.8	589	557E-01	-14.8	•296	•122	126	-18.9
	• 464	-7.96	331	149E-02	-10.4	.232	•922E-02	.631E-01	-20.7
	•681	-4.04	158	157E-01	-5.24	.103	.181E-01	•774	-9.57
	1.00	.122E-01	634E-03	.493E-03	.398E-02	.654E-03	904E-03	.108E-01	173
	1.47	-294.	.661	.179E-01	-295.	715	193E-01	-1.46	.787
	2.15	-13.8	•770	.444E-01	6.62	546	142	960	-1.66
	3.16	14.8	110	•237	672E-01	-4.71	327	.150	-17.0
ERMS:	•316	18.5	•703	•510	22.9	•454	•515	1.26	22.1
	• 464	11.0	.384	• 358	15.0	.442	•437	1.15	24.1
	•681	4 • 68	.178	.116	6.71	.210	.194	1.08	10.5
	1.00	.164	.368E-02	.203E-01	.177	.440E-02	.206E-01	608E-01	.712
	1.47	371.	.663	.101	372.	.716	.106	1.70	.793
	2.15	22.8	.781	.240	18.3	•588	.240	1.87	3.08
	3.16	32.5	1.06	•589	36.0	6.41	.626	1.29	22.4
ESTO:	•316	14.2	.364	• 507	17.5	.345	•500	1.26	11.6
	.464	7.65	.193	.358	10.9	•377	.437	1.15	12.4
	.681		806E-01	.115	4.19	.183	.194	.749	4.39
	1.00	•164	•362E-02	.203E-01	.177	.435E-02	.206E-01	5988-01	690
	1.47	226.	.3918-01	.990E-01	227.	414E-01	.105	859	9888-01
	2.15	18.1	.135	.236	17.1	.218	.194	1.61	2.59
	3.16	28.9	1.05	539	36.0	4.35	.534	1.28	14.5

Table 3.14 Error Statistics vs B_{ratio} , OPTRVR, S/N=30db, ρ =0.8, θ_{sep} =1.5°

Table 3.15 Error Statistics vs B_{ratio}, OPTRVR, S/N=30db, ρ =0.5, θ _{sep}=1.5°

QTY	BRATIO	ALFA	THETA	THEDOT	ALFAR	THETAR	THROOT	В.,	WSC
EMEAN:	•316	-2.26	817	187	-7.08	522	167	•205	-18.0
	• 464	699	634	·-•162	-5.25	577	144	•945	-9.36
	.681	756	197	156E-01	-2.03	302E-01	.697E-01	915	-4.57
	1.00	108E-01	198E-02	•981E-03	403E-01	.681E-02	163E-02	.575E-01	531
	1.47	-38.0	•581	.612E-01	-38.8	729	892E-01	-1.44	•683
	2.15	-9.21	•774	.889E-01	-7.39	368	66CE-01	-1.42	144
	3.16	3.39	.485	•377E-01	4.16	-, 965	249	608E-01	-29.2
ERMS:	.316	4.60	•933	•542	7.75	•717	•566	1.34	21.4
	• 464	2.47	• 709	•397	5.73	.704	479	1.37	11.0
	•681	•803	.200	•727E-01	2.63	•312	.254	1.27	6.87
	1.00	•158	.891E-02	.250E-01	.182	.177E-01	.307E-01	•165	1.19
	1.47	41.5	•584	•150 °	42.3	.733	.204	1.70	.730
	2.15	10.7	.784	.214	9.15	398	.841E-01	1.75	1.15
	3.16	3.70	.515	•302	4.33	1.09	.291	1.34	29.9
ESTO:	•316	3.30	•451	• 508	3.17	• 492	•541	1.32	11.6
	• 464	2.36	.318	.362	2.29	• 404	456	• 996	5.84
	.081	.264	.345E-01	.710E-01	1.68	•311	245	.884	- 5.14
	1.00	.158	.869E-02	.250E-01	.177	.163E-01	.307E-01	155	1.07
	1.47	16.7	.569E-01	.137	16.9	.728E-01	.183	899	. 257
	2.15	5.38	.121	.194	5 • 40	•150	.521E-01	1.01	1.14
	3.16	1.50	•171	.300	1.22	.500	.152	1.34	. 0.61

Table 3.16 Error Statistics vs B_{ratio} , OPTRVR, S/N=20db, ρ =0.5, θ_{sep} =1.5°

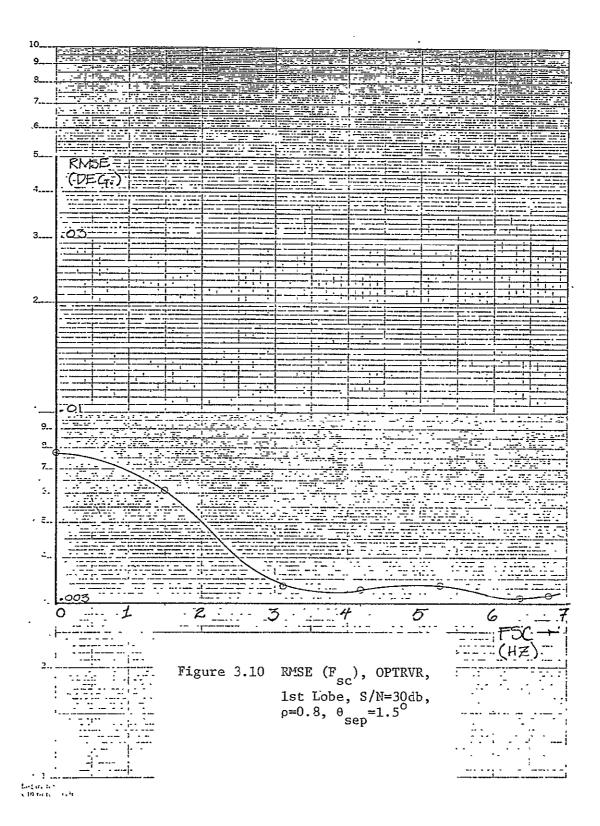
- 1. An estimation of α and α_R by integration of the signal, such as in done here, may be especially vulnerable to uncertainties in other parameters that affect signal energy, such as beam width; and
- 2. The errors in the θ and θ_R components are heavily biased, when $\beta_{\text{ratio}} \neq 1$, indicating loss of LOE validity, specifically wrt decoupling of estimates of errors.

Perhaps peak detection, maybe in conjunction with an integration approach, would provide more robust estimates of α and α_R . Smaller errors in the θ and θ_R components should then result, but the residual errors might be reduced further by having the <u>nominal</u> beam width at each air terminal coded and transmitted in the MLS preamble. Additional robustness and possibly some simplification advantages might result from use in the receiver of a p(·) function which doesn't model exactly any particular transmitting antenna selectivity function but does produce a best fit in some sense over the class of transmitting antenna selectivity functions to which the receiver is exposed. This is a problem area that needs further study.

Figure 3.10 presents an RMSE (F_{sc}) study for scalloping rates in the first lobe of the rep. rate sampled signal spectrum, i.e.

$$F_{sc} \le \frac{13.5}{2} \text{ Hz} = 6.75 \text{ Hz}$$
 (3.32)

All the values of F_{SC} for which the RMSE was calculated, except 0.0 Hz, cause β to integrate an integral number of times around a 2π interval as the run progresses hence the results should be independent of the initial β . The RMSE value at 0.0 Hz is probably dependent upon the



value of β , 0°, during the run. Table 3.17 shows all computed statistics of all error components for this simulation run.

Figure 3.11 and the associated Tables 3.18 thru 3.23 present the results of several statistical error studies versus \mathbf{F}_{sc} with the latter ranging on the fifth lobe of the rep. rate sampled signal spectrum, i.e.

$$47.25 \le F_{SC} \le 60.75 \text{ Hz}.$$
 (3.23)

These studies indicate

- 1. The OPTRVR without constraints is definitely superior to the same receiver with constraints (Tables 3.18 and 3.19).
- 2. The SUBOPT performance is the same with and without constraints (Tables 3.20 and 3.21).
- 3. The OPTRVR with tethered estimates β , \hat{w}_{sc} as shown performs the same with and without constraints (Tables 3.22 and 3.23).
- 4. Items (2) and (3) above suggest it is the constraint on $\hat{w}_{\underline{sc}}$ only that degrades the OPTRVR performance referenced in item (1) above.

Relaxing the constraint on \hat{w}_{SC} in OPTRVR may be beneficial here without harming the performance for low \mathbf{F}_{SC} cases, but there is no certainty of that without more tests. The benefits of the constraints generally were established in Figure 3.8 but that involved the SUBOPT receiver where there was no \mathbf{w}_{SC} estimate. Clearly, relaxing the $\hat{\mathbf{w}}_{\text{SC}}$ constraint in the OPTRVR will not in any sense enable tracking of \mathbf{w}_{SC} above half the rep. rate, since the 5D LOE does not exploit individually (for \mathbf{w}_{SC} information) the TO and FRO scan pulses (as the 6D LOE would do). Further sutdy at other values of S/N, ρ and θ_{SCD} are needed here.

0	Y	FSC	ALFA	THETA	THEDOT	ALFAR	THETAR	THRDOT	8	WSC
EMEAN			.296E-02	148E-03	•587E-03	272E-02	.123E-03	892E-03	 153	-1,13
	1.		•118E-01	549E-03_		404E-03	517E-03-	133E-02	•133E-01.	
	3.	11	•132E-01	328E-03	816E-03	104E-01	.105E-02	972E-03	•128E-01	286E-0
	4 • :	19	147E-01	470E-03	290E-03	428E-02 _	517E-03_			
	5 • 1	27	•932E-02	247E-03	624E-03	•737E-02	.581E-03	453E-03	.183E-01	224E-0
 	6 • 1	35	810E-02	240E-03	530E-03.	714E-02	.722E-03	588E-03	865E-02.	270E-0
	6.	75	.749E-03	378E-04	•227E-03	•150E-02	.617E-03	110E-02	114E-01	•825
ERM:	. 0.		•167	.377E-02	.210E-01	•179	.423E-02	.207E-01	•186	1.42
		49	•161	361E-02.	203E-01	174	412E-02	a195E-01_	_ •588E-01.	834
	3 • :	11	.168	.334E-02	.194E-01	•177	,412E-02	.200E-01	•469E-01	•781
	4 • :	19	164	327E-02	•193E-01.	177	. •417E-02	210E-01	552E-01	
	5 + 2	27	•167	.337E-02	.197E-01	•181	.414E-02	.207E-01	•523E-01	.813
	6.	35	165	310E-02_	192E-01.	171	403E-02-	196E-01.	500E-01	797
	6.	75	.159	•315E-02	•195E -0 1	.180	.368E-02	•189E-01	.103	1.09
EST)		.167	-377E-02	•210E-01	.179	.423E-02	.207E-01	.105	.873
	1 • •	49	161	357E-02.	203E-01.	174	409E-02_	195E-01.	572E-01_	834
	3 • ∶	11	.168	∘333E - 02	.194E-01	.177	•399E-02	.200E-01	.451E-01	•781
	4.	19	164	4324E-02_	a193E-01_		414E-02	210E-01	550E-01	791
n	5.7	2.7	.166	.336E-02	.197E-01	.181	.410E-02	.207E-01	.490E-01	.813.
×	6 a	35	165	309E-02.	192E-01.	170	397E=0.2_	196E=01.	492E-01	796 م
	6.	75	.159	.315E-U2	.195E-01	.180	.363E-02	.189E-01	•103	713
					ngan ang mga kang mga mga mga mga mga mga mga mga mga mg					
· · · · · · · · · · · · · · · · · · ·			ه دوه سند سببانېده سند مهوسی ساه می							
		-				٠.	•		***************************************	
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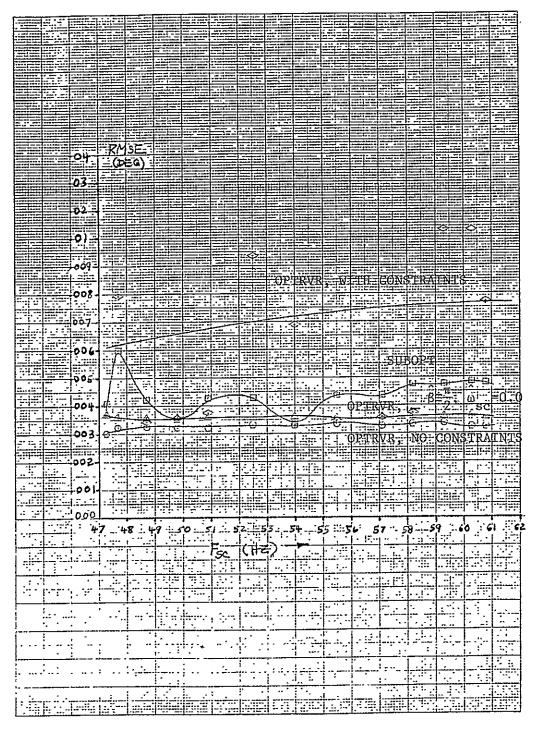


Figure 3.11 RMSE (F $_{sc}$), comparison of receivers and effects of constraints, 5th lobe, S/N=30db, $\rho{=}0.8,~\theta_{sep}{=}1.5^{\circ}$

CTY	FSC	ALFA	THETA	THEDOT	ALFAR	THETAR	THROOT	В	MSC
EXEAN:	47.3	.2741-02	.106E-03	.542E-04	-857E-02	.700E-03	268E-03	-,739E-02	.201E-0
C112 A111	47.7		.m.4536=04	.168E-03	.235L-03			245E-02	:
	40.7	.5346-62	.1186-03	.203L-03	.561E-02	414E-03	466E-03	103E-03	.3776-0
	49.8		3lof-03	.112E-03	.450E-03			635E-02	.7126-0
	. 50.9	943E-62	2018-03	240E-03	.702E-02	646E-03	1038-02	599E-02	T-3416-0
	52.0	.807:-02	2856-03	.281E-03	.112E-02			2098-02	.163E-0
	54.0	.540L-02	190E03	287L-03	·2631-02		419E-03	315E-01	536E-C
	55.5	.7331-02	2116-03	.439E-03			386E-03	.275E~02	.258E~C
	57.1			757E-03 .294E-03	.454E-02	347E-03	218E-03	•360E+03	.335E-0
					-,256E-04	1636-04	143E-02	3768-02	•462£~0
	56.2		554F-04	.606F-03			839E-03	114E-02	.602E-0
	59.3	.532E-C2	•140E-03	.195E-03	•637E-03	.233E-04			
	60.3	4591-02	1806-04,	.1016-03	.292E-02	.214E-03	.292E-04_		,5728-0
	6.33	.29ct-02	.175t-03	.1266-03	.442b-02	.317E-03	454E-03	.9298-03	•674E-0
ERYS:	47.3	.165	.301E-U2	.1928-01	.176	.368E-02	.194E-01	.647E-01	.935
	47.7	651.	.326E-02	.205E-01	.175	•393E-02	.204E-01	.474E-01	•698
,	48.7	.162	.325E-C2	199E-G1	.174	.369E-02	.202E-01	.591E-01	.972
	49.3	.163	·3222-02	.198E-01	.174	.379E-02	.205E-01	.528E-01	.885
A	50.9	160	.3208-02	.202E-C1	.178	.3675-02	.188E-01	.671E-01	1.01
	52.5	.162	.330E-02	.204E-01	.176	.388E-02	.203E-01	.410E-UI	.681
	54.)	.1c2	.328E-02	204E-01	.174	.374E-02	.199E-01	.390E-01	.670
	55.5	.101	.333E-02	.203E-01	.179	.3728-02	.194E-01	.470E-01	.753
	57.1	101	326E-02	202E-01	176	- 378E-02	201E-01	,446E-01	720
	F6.2	.165	v331:-62	.203E-C1	.173	.3905-02	.2008-01	.412E-01	.603
	-59.3	.100	-337E-02	.2056-01		375E-02	201E-01	- 411E-01	
		.164	•324E-C2	.200E-01	.178	.391E-02	.201E-01	.5818-01	.859
	<u> </u>		324E-02	1988-01	.176	375E-02	.196E-01	347E-01	.615
		1197	• 52 12 02						
in Lato:	47.3	165	.3016-02	1926-01	.175	.361E-02	194E-01	.643E-01	934
	47•7	.158	3268-62	. 205E-61_	.175	393E-02_	204E-01	.473E-01	. 698
	48.7	.1c2	.325E-C2	.199F-01	.174	.367E-02	2025-01	.591E-C1	.971
	49.3.	.163	\$321£, - 02	1G88-G1	174	379E-02_	0205E- <u>_</u> 01_	5256-01_	•885
	50.9	.159	.3196-62	.202E-01	.178	.361E-02	.187E-01	.669E-01	1.01
	52.5	.162	.328E-02	.204E-01	.178	.388E-02	.2035-01	.409E-01	* 6c i
	54.0	.162	.327E-02	.204E-01	.174	.374E-02	-199E-01	~~.230E-01	.670
	55.5	.161	.3326-02	.2036-01	.178	.37CE-02	J93E-01	.469E-01	ه 753
	57.1	.161	326E-02	.2024-01	.176	.377E-02	-201E-01		1720
	58.2	.lc5	.3316-02	.203E-01	.173	.390E-02	.200E-01	410E-01	.681
	54.3	166	3361-02	.205E-01	.176	.375E-02	2016-01	5410E-01	.703
	e0.3	• 164	.324E-C2	.200E-01	.178	390E-02	.201E-01	.579E-01	.859
	60.8	165	3248-02	- 198E-01		374E-02	1966-01	347E-01	615
	C C & C	• 1442	* 2 C T C ' V C	*1,05 01	• 2 1 0	40116 04	4170F 0T	SOUTH OF	4062

aty .	FSC	ALFA	THETA	THEDOT	ALFAR	THETAR	THROOT	В	WSC
EME AN :	47.3	.176	223E-02	·116=-02	282	477E~U2	169E-02	179	295•
··· • • •	47.7	•144	2686-02	•4792-UZ	+22C	478E-02	617E-02	7.118	293.
	45.7	* A & U	710E-03	•918E-U3	.163	•199E-02	1265-02	113	304.
u• ·	49.8	.162	8396-33	•€47E+03	.170	.229E-32	819E-G3	106	311
	p0.9	•11¢	12ob-v2	•199E-⊍2	•179	.295E-02	253E-02	104	317.
	52.5	•152	490E-62	473E-04	• 224	.827E-62	915E-03	560E-02	290.
	54 . u	o li u	•142t-43	•616E - 02	•152	.567E-03	777E-02	-1.59	299.
44 F 41 F 1 F	50.5	.922E-ul	1636-62	•428E-C4	.147		3168-03	940E-01	
	57.1	.115	132E-C2	.122E-02	•182	.288E-G2		109	356.
_	56.2	.165	7922-13	.758L-03	.174	.219E-U2		111	363.
	54.3	•192	8656-02	•910E-03	· 249	.132E-01		601E-02	333.
	66.3	\$ 242	753E-C2	. 667E-62	.296	.123E-01	761E-02	111	355.
, ,	60.8	•139	5316-02	.644E-02	•192	.789E-UZ	623E-02	115	343.
ERMS:	47.3	. 242	•404t-02	.196E-61	•334	.6425-02	.208E-01	1.66	295.
	47.7	• 239	•795€ - €2	•424E-01	.304	.108E-01	•464E-01	•973	293•
	48.7	• 2 ú b	•341E-02	.196E-01	• 249	.469E-02	.206E-01	•947	304.
	49.0	• 2 c 5	• 355t -1·2	•200E-01	.278	•491E-62	·212E-01	•935	311.
	50.9	• 210	•37oF-02	.210E-01	• 279	.513E-02	.205E-01	•927	31,7.
	52.5	•277	•934b-12	.477E-61	.341		_ •554E-01	. 977	290•
	54.0	• 236	.667E-42	.492E-01	• 269	.935E-02	.567E-01	1.59	299.
၀ ၁	55.5	·2~1	.34512	•192E-01	•238	.483E-C2	.206E-01	.877	347.
•	57.1	• 2 13 6	.359E-02	.196E-01	•267	.566E-02	.204E-01	.851	356.
	56.2	·2i7	• 372 i - i 2	.206E-01	• 256	•462E-02.	197E-01	.807	363.
	59.3	₀2៥6	.12aE-J1	.518E-U1	•369	•182E-01	•579E-C1	•802	333.
	t(.3	ø329 . ,	•126£-31	.613E-01	.387	•170E-61	647E-01	. •938	355•
	61.08	.215	•771f -02	.3888-31	. 286	.113E-01	•471E-01	1.45	343•
ESTO:	47.3	.166	+333E-02	.196E-01	•179	.429E-02	.207E-01	1.65	•532
	47.7	•141	•748E-32	•421E-01	.209	.973E-02	•460E-01	.966	9.54
	40.7	•179	•3348-62	.196E-01	.168	•424E-02	.206E-01	.940	1.48
	49.8	• i 7 d	•345E - 02	. •200E-01	•219	•434E-02,		. •929	1.49
	50.9	.179	.3:56-62	•2∪9£-01	.214	.426E-02	.203E-01	•921	1.23
	52.5	•231	.795E-02	•477E−61	•256	•980E-02	•554E-01	•977	2 • 33
	54. u	•214	.6875-62	.489E-01	.222	•934E-02	. •562E-01	•167	1.34
	55.5	•179	•329ē-02	•192L-01	•187	• 420E-02	.206E-01	•872 <u> </u>	.768
	57.J	•174	•333E€2	.195E-U1	.195	•409E-02	.202E-01	• 844	1.73
· -	5 t + 2	.17s	•364E - 02	·206E-61	.188	.407E-02.		799	2.10
	59.3	•215	.91tE-02	.517E-01	.272	•126E-01	•578E-C1	.802	2.45
	63.3	. 260	.101E-01	.610E-01	. 249	•118E-01	.643E-01	•932	15.7
•	66.0	.164	ა 560E−u2	•363E-U1	.212	.811E-02	.467E-01	1.45	3.28

Table 3.19 Error Stastistics vs F_{sc}, OPTRVR, 5th Lobe, S/N=30db, p=0.8, 0 =1.5°, WITH CONSTRAINTS_____

QTY	FSC FSC	ALFA	THETA	THEDOT	ALFAR	THETAR	THROOT
EMEAN:	47.3	5548-01	222E02	.152E-03	437E-01	195E-02	454E-04
W((# 7))	47.7		171E-02	.628E-03	.5208-01	.2536-02	129E-02
	48.7	217E-01	.5478-03	.167E-03	291E-01	.2322-03	2496-03
	49.8	1788-01	144E-03	.529E-03	173E-01	.585E-03	613E-03
	50.9	-,195E-01	126E-03	~.112E-03	102E-01	.120E~02	3785-03
	52.5	249E-02	5918-03	.4098-03	.196E-01	9548-03	315E03
	54.0	102E-01	.403E-04	62725-03	1175-01	~4602~03	688E-03
	55.5	608E-02	1485-03		1325-01	.789E-03	303E-03
	57.1	145E-01		577E-03	346E-01	.1398-03	165E-93
	58.2	101E-01	₩.353E~03	.2325-03		1526-03	985E-03
	59.3	2658-01	217E-03	700E-03	469E-02	1150~03	383E-03
	50°3	.234E-Q1	126E-02	.172E-03	.1496-01	30-3161 ₆	353E-C3
	60.8	6725-01	3146-02	•335E~03	.550E-01	.343E-02	7116-03
	6000	10122-01	-03276-02	00000	0550E 02		
ERMS:	47.3	025	410E-02	.1936-01	.231	.4492-02	.1978-01
	47.7	.224	.588E-02	.2535-01	. 215	.663E~02	.2536-01
	48.7	.210	~.421E-02	.2318-01	. 227	.510E-02	.219E-01
	47.8	.198	.353E-02	.1935-61	.214	.441E-02	.266E-61
	50.9	.195	- 425E-82	- a223E-01	. 225	~549E-02	.243601
	52.5	.198	6429E-02	.219E-01	. 226	.4575-02	.216E~01
	54.0	.193	.3406-02	01805-01	.211	419E-02	.7885-07
	55.5	•220	.437E-0Z	°4239E01	.221	.5035-02	。225E~Ul
	57.1	200	437E-02	227E01	.207	.5035-02	.2215-01
	58.2	.219	.474E-02	.230E-01	.259	.501E-02	.220E-01
	59.3	203	4756-02	.230E-01	6267 · · · · · · · · · · · · · · · · · · ·	552E-Q2	
	60.3	.206	482E-0Z	.224E-01	.239	".712E-02	.2855-01
	60.5	.216	480E-02	.1772-01	· 207	.547E-02	.1705-01
				"" * O !! # * * *			
ESTD:	47.3	.213	.3446-02	.193E-01	. 227	-404E-02	.197E-01
	47.7	8218	- 2026-05	.253E~UL	200	6135-02	.2532-01
	46.7	-209	.418E-02	*537E-01	.225	2509E-02	.2196-02
.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	<u> 49.8</u>	.197	0353E-02.	0191E~01.	214	6376-02	206E~01
	50.9	e 195	.425E~Q2	*5562-0J	0224	· .500E-02	.2435-01
	52.5	198ء -	%4255-02	.2195-01	.225	447E-02	.2165-61
	54.0	.193	-3402-02	.1805-01	.211	.416E-02	.1286-01
	55.5	.220	4372~02	.239E-01	. 220	.502E-02	.225E-01
	57.1	£299	6434E-02	.2276-01	، 204	.5036-02	.221E-01
	58.2	219	4725-02_	230E-01.	255	65015-02	220EGI
	59.3	s 203	64766-02	.230E-G1	.267	6552E-02	. 260E-01
ı	60°3	267ء	455E-02	02848-01	•230	6935-02	.286E-01
/		.205	364E-02	~~~177E-01	.200	~ 426E~02	.169E-02

Q	TY FSC	· ALFA	THETA	THEDOT	"ALFAR '	THETAR	THROOT	
EMEA	Nt " 47.3 - "	554E-01	.222E-02	152E-03	437E-01	195E-02	464E-04	
	47.7	•494E-01	171E-02	•628E-03	.520E-01	.253E-02	129E-02	
	48.7	217E-01	•547E-03~	-167E-03	291E-01	.232E-03	249E-03	
	49.8	173E-01	144E-03	•529E-03	173E-01	.585E-03	613E-03	
	`` 50•9	195E-01	126E-03	112E-03	102E-01	.120E-02	378E-03 -	
	52.5	249E-02	591E-03	.409E-03	.196E-01	.954E-03	315E-03	
	54.0	102E-01	.403E-04	- •272E-03	117E-01	.460E-03	~.688E-03 "	
	55.5	606E-02	148E-03	.876E-03	132E-01	.789E-03	303E-03	
	57.1	~145E-01	500E-03	.577E-03	346E-01	-139E-03	165E-03 T	
	58.2	101E-01	398E-03	•232E-03	454E-01	152E-03	985E-03	
	59.3	285E-01	.217E-03	" .700E-03	469E-02		383E-03	
	60.3	.234E-01	126E-02	.172E-03	.149E-01	.161E-02	323E-03	
		.672E-01	314E-02	.335E-03	530E-01		711E-03	
ERM	- · · · · · · · · · · · · · · · · · · ·	• 220	.410E-02		231	.449E-02	.197E-01	
****	47.7	• 224	.588E-02	•253E-01	.215	.663E - 02	•253E-01	
	48.7	•210	-421E-02	.231E-01	.227	~ .510E-02	.219E-01	
	49.8	.198	.353E-02	•191E-01	.214	.441E-02	.206E-01	
	50.9 ~~	. 196	.425E-02	.228E-01	.225	•543E-02	243E-01	
	52.5	.198	•429E-02	.219E-01	.226	.457E-02	.216E-01	
	54.0	.193	•340E-02	.180E-01	.211 ' ""	•419E-02	188E-01	
	55.5	.220	•437E-02	.239E-01	.221	.508E-02	•225E-01	
	57.1	•200	.437E-02	.227E-01		.503E-02"	221E-01 -	(»+ · · · · · · · · · · · · · · · · · ·
•	58.2	.219 ·	•474E-02	.230E-01	.259	•501E-02	.220E-01	
	59.3	205	.476E-02	° 230E-01	.267	-552E-02	260E-01	
	60.3	.208	.482E-02	•224E-01	.239	•712E-02	.286E-01	
	60.8		480E-02	177E-01	•207	-547E-02	•170E-01	
EST	D: 47.3	. 213	.344E-02	193E-01	.227	.404E-02	197E-01	
	47.7	.218	.562E-02	.253E-01	.208	.613E-02	.253E-01	
•	48.7	.209	.418E-02	.231E-01	~ .225	509E-02	219E-01	
	49.8	•197	.353E-02	•191E-01	.214	.437E-02	.206E-01	1
	50.9	195	425E-02	.228E-01	.224	•530E-02	243E-01	
	52.5	.198	425E-02	•219E-01	225	•447E-02	•216E-01	
	54.0	.193	•340E-02	-180E-01	.211	.416E-02		
	55.5	•220	.437E-02	•239E-01	•220	•502E-02	•225E-01	
	57.1	' •199 ' ' "	434E-02	~ 227E-01	• 204 ` "	-503E-02		
	58.2	•177 •219	•472E-02	•230E-01	• 20 4 • 255		•221E=01	
	59.3	203		· 230E-01		501E-02		
	60.3				•267	•552E-02	-260E-01	
	60.8	207	.465E-02	•224E-01	238	.693E-02	.286E-01	
	00.0	.205	.364E-02	.177E-01	.200	•426E-02	169E-01	

QTY	FSC	ALFA	THETA	THEDOT	ALFAR	THEYAR	THROOT	В	W S C
EMEAN:	47.3	.162	1426-02	7612-03	.259	.3316-02	.191E-03	817E-13	297.
	47.7	J952E-01	1645-02	3005-03	.145	.213E-02	~.186E03	.439E-12	2996
	48.7	a941E-01	101E-02	2675-03	.146	•224E-02	2262-03	.108E-13	306 .
•	49.8	.939E-01	-,10GE-02	292E-03	o 146	•222E-02	2236-03	*881E~14	313.
	50.9	.936E~€1	 973£-53	-,278E-63	e ±46	.216E-02	260E-03	.3845-12	320.
	52,5	.936E-01	1002-02	,2018-03	.146	.219E-02	2170-03	204E-14	330.
	54.3	.118	1135-02	243E-03	.173	.238E-02	2728-03	-1.57	339.
	55.5	.939E-01	994E-03	2608-03	·146	.218E-02	-02419-03	.319E-12	349.
	57.1	8949E-01	1048-02	268E-03	.146	•215E~02	203E-03	4275-12	359.
	5 3. 2	.945E-C1	102E-02	272E-03	.145	215E-02	-,251E-03	-182E-12	366.
	59e3	∘937E-Cl	~ ₹9928~03	2958-03	.146	.219E-02	191503	.421E-12	372.
	6 0. 3	.941E-01	1016-02	2806~03	.146	.218E-02	2156-03	335E-12	379.
	8.03	.749E-01	9226-03	1245-03	.113	.1946-62	3735-03	1846-12	362.
ERMS:	47.3	e232	•369E-62	.199E-01	.314	.542E-02	.2102-01	1.57	297.
	47.7	.213	.3598-02	.201E~01	. 257	.498E-02	.217E-G1	.907	299.
	46.7	· •265	.356E-02	.199E-01	.239	.479E-02	.208E-01	.907	306.
	4 ዎ 8	.201	J356E-D2	.200E-01	. 260	.485E-02	.213E-01	.907	313,
	50,9	. 200	•356E-32	.200E-01	.255	.475E-C2	·269E~61	9٤7 م	326.
	52.5	025W	.35?E-C2	.2002-01	.2¢l	.479E-02	.2116-G1	،907	330.
	54.0	·203	.3618-02	.20UE-01	.246	.403E-02	.209E-01	1.57	339.
	55.5	£255	.3548-02	.2005-01	.238	6474E-02	.2G75-01	.907	34,90
	57.1	.199	.357E-02	1995-01	.239	.474E-02	.208E-01	.907	359.
	58.2	.198	.361E-02	.263E-01	.237	.469E-02	.205E-01	.907	356.
	59.3	195ء	.360E-62	.2022-61	. Z & L	55-3564°	.2135-01	1957	372.
	cũsl	.193	.364E-62	.203E-01	٠249	4735-02	.210E-01	,967	379.
	50. b	.182	.353E-02	.200E-01	.208	.464E~02	.208E-01	1.57	382.
ESTO:	47.2	.167	.340E-02	.1995-01	.179	.429E-02	.2108-01	1.57	.748E-04
	47.7	.191	₀343E-02	.201E-01	.211	.4505-02	.217E-01	.907	.507E-64
	46.7	.182	. 3418-02	.199E-01	.239	. 423€ ~ 02	.208G-01	, 907	Ţ
	49.9	.178	. 341E-02	.200E-01	·216	.431E-02	.213E-01	.907	.716E-64
	50.9	.177	.343E-02	.20GE-01	.210	.423E-02	°504E+01	.907	ì
	52.5	a 1.77	。343E32	.200801	.216	.4265-02	.211E-01	°607	•143E~63
	54.0	s166	•342E-02	.200E-01	.175	.4268-02	.2692-01	.559E ~ 06	.131E-03
	55.5	.183	.34UE~02	.200E-01	.188	64215-02	.207E-01	.957 .	.131E-03
	57:1	J1.75	6341E-02	.1992-01	4189	.422E-02	.203E-01	.907	1
	១ំ8∍2	.1.74	346E~02	.202E-01	.166	. 0417E-02	.205E-01	° \$07	.226E-03
	59.3	.171	6346E-02	.20:25-01	.216	.437E~02	.2136401	.907	.200E-03
	£0.3	.168	.350E-02	.2036-01	.202	.4198-02	.210E-01	. 907	.143E-63
	60.8	.1 65	.3416+02	.200E-01	.175	.426E+02	.208 E-01	1.57	.20⊃E-v3

Table 3.22 Error Stastistics vs F $_{sc}$, OPTRVR, 5th Lobe, $(\hat{\beta}, \omega_{sc})$ tethered to $(\pi/2, 0)$ S/N=30db, ρ =0.8, θ_{sep} =1.5 $^{\circ}$, NO CONSTRAINTS

YTP	FSC	ALFA	THETA	THEOOT	ALFAR	THETAR	THROOF	3	MEC
. EMEAN:	47.3		-0142E-02	7618-03	.259	.331E-62	.191E-03	-0017E-13	297.
CHEAN	47.7	.952E-01	W	3008-03	.146	.213E-02	186E-UB_	0439E-12	2996
	48.7	.941E-01	-,1015-02	267E-03	.146	.224E-02	w,226E~03	0106E-13	3060
	49.8	.939E-01	100E-02	292E-03	0145	.222E-02	-,2238-03	.631E-14	313
	50.9		₩.973E-03	2762-03	.166	-216E-02	-,2682-93°	~~.384E-12	3200
	52.5	.938E-01	340E-02	~,281E-03	.146	.219E-02	217E-03	~,2845~14	330.
	- 54.0	.113	113E-02	-,243E-03	.173	- 2385-02	2726-33	-1.57	337。
	55.5	.9395-01	~. 994E~33	260E-03	.145	.2135-02	24XE-03	.3192-12	349
	57°1	9496-01	- 1045-02	2685-03	145	.215E-02	203E-03	4272-12	359.
		6945E-01	102E-02	- 272E-03	.145	.215E-02	251E-03	.182E-12	365.
	_ 58.2	-937E-01	9925-03	2952-03	.146	.219E-02	1918-03	~ 4215-12 "	372.
	59.3	.941E-01	-c101E-02	-,2805-03	.146	.218E-02	215E-03	3355-12	379.
	_ 60.3	249E+01	92226-03	1246-03	113	.184E-02	373E-03	~~184E-12 `	.382.
	60.8	* 1445-OT	-84555-03	-04246,05	0222				
,	47.3	232	3698~92°	.1996-01	.314	542E-02		1.57	297.
ERMS:	47.7	.213	.359E+02	.2018-01	.257 .	498E-02	.217E-01	907	2995
	48.7	205	3565-02	1995-01	239	- 479E-02	.258E-01	o957	
	49.8	.201	«356€ ~ 02	.2006-01	.260	.4855-02	.213E-01	.957	313.
		.200	~ 356E~02	- 200E-01	255	4758-02	.209E-01	2907	320.
	50.9		.357E~02	.200E-01	.261	6479E-02	.2115-01	0907	3806
	52,5			0200E-01	246		.2075-01	1.57	329,
	54,0	.203	.3618-02 .3546-02	.200E-01	. 235	-474E-02	.207E-01	.967	3490
	55,5	.205		.1996-01	.239	- 474E-02	-208E-01	.907	350.
	57.1	.199	.357E-02	.203E-01	.237	4695-02	.2055-01	,907	366,
1174,	58.2	198	361ā~02	.202E-01	251	48ZE-02	- ,213E-01	6907	372.
	59.3	.195	-3605-62		.249	.4736-02	.210E-01	.907	. 379.
	60.3		03645-02	02035-01_	208		10-3803.	1.57	382.
	် ပါ₃ဗိ	.182	.333E-32	.200E-01	\$ & Y O	\$404F-0E	\$2000 O4	2401	
·			.340E-02	.1995-51	.179	~429E-02	- a210E-01	1.57	· 7485-01
ESTD:	47.3	.167		.2015-01	.211	.4505-02	.2178-01	,907	.807 <i>E</i> -04
	47.7	191	343E~C2'	1992-01			~ 288E~01	.907	-
	48.7	182	3415-02	. 200E-01	.216	.4316-02	10~2512°	3957	.7166-0
	49.8	179	341E-02 343E-02		210	.4235-02	209E~01	7005	
	50.9	.177		200E-01	.216	.426E-08	.2115-01	.907	.2436-03
	_ 52.5	177	3435-02				12098-01	5598-06	.1316-0
	54.0	.166	-342E-02		.188	.4215-02	.2075-01	3967	.1315-03
	. 55.5		53405-02	.2005-01	.189 	64225-02	208É-01	- 2907	, , ,
	57.1	.175	.3412-02	.100E-01	* 188	3422E-02	.205E-01		.2265-03
	58.2			2025~01		4305-02	2236-01		-200E-V
	59.3	.171	.346E-02	.2026-01	• 226 202	.419E-03	10-30150	.907	.1438-0
	60.3	1.68	350E-02	.2036-01	. 202		2685-01	2057	205E-0
	60.8	0165	.541E-02	.200E-61	.175	.425E-02	2 7 0 0 2 4 9 7	70 71	45000 00

Figures 3.12 thru 3.23 present a study of the interference acquisition capabilities of the interference trackers in the OPTRVR and SUBOPT designs. The 4 top traces on each figure are error time histories repectively (from the top) of the α , θ , α_R and θ_R estimate components; the bottom tract shows when the step of interference (ρ =0.8) occurs and simultaneously when the interference tracker estimate-vector elements are released from the idler values (equations 3.15 thru 3.19 above). The direct path pulse is being tracked from time zero. All plots have the same time-axis scaling.

Figures 3.11 thru 3.20 for the OPTRVR design (with constraints) show the following:

 Successful pull-in for small scalloping rates and separation angles as small as the following:

a.
$$\theta_{\text{sep}} = 0.25^{\circ} \text{ @ S/N} = 40 \text{ db}$$
 (Figure 3.12)

b.
$$\Theta_{\text{sep}} = 0.5^{\circ} \text{ @ S/N} = 20 \text{ db}$$
 (Figure 3.16)

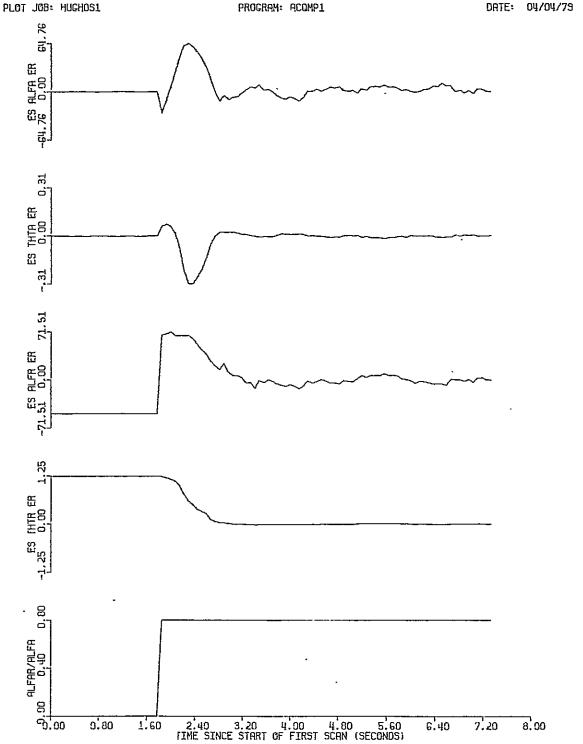
c.
$$\theta_{\text{sep}} = 1^{\circ} @ S/N = 14 \text{ db}$$
 (Figure 3.19)

- 2. Successful pull-in for small scalloping rates and separation angles probably extending nearly to the window edge (4°).
- 3. Successful pull-in @ S/N 40 db, $\theta_{\text{sep}} = 1^{\circ}$ and F_{sc} in the 5th lobe (Figure 3.20). The exact F_{sc} (51.3 Hz) and initial β (-168°) were selected to produce, in the middle of the run, a maximum enhancement of the TO pulse and a maximum cancellation of the FRO pulse.

Figures 3.21 thru 3.23 for the SUBOPT design show the following:

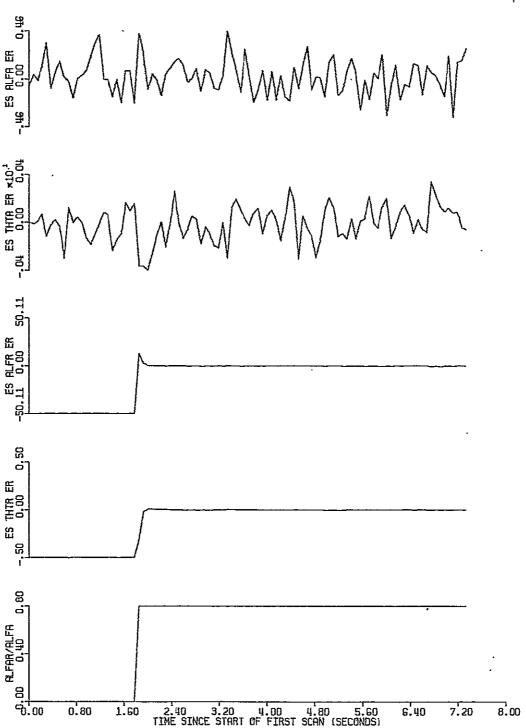
1. Results for $\theta_{\text{sep}} = 0.5^{\circ}$ and $F_{\text{sc}} = 0.6 \text{ Hz} \ \underline{\text{(low)}}$:

SIM. JOB: HUGHOLO FILE NO: 512211U301 DRTE: 94/03/79



SCENARIO: ACOSITN3, PMLS1, BMLS= 1.0 DEC, DELT= .0740741 SEC, KM=109, KSTART= 26 S/N= 40.0 DB, RHO= .8, BETA= 45.0 DEC,FSC=, .600 HZ, THESEP= .250 DEC RECEIVER: OPTIML, ADAPTIV, UNTETHAD, POPT1, BRCVR= 1.0 DEC INTERFERENCE TRACKER IDLER VALUES: .5, 1.5 DEC, 0.0 DEC/SEC, 90.0 DEC, 0.0 HZ BETA ESTIMATE ERROR: INITIAL= -45.0 ,FINAL= .390 DEC FSC ESTIMATE ERROR: INITIAL= .600 ,FINAL= .241E-01HZ

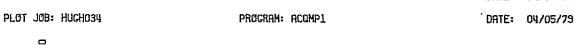
Figure 3.12 Interference Acquisition, OPTRVR, S/N=30db, ρ =0.8, θ_{sep} =0.25°, β =45°, F_{sc} =0.6Hz

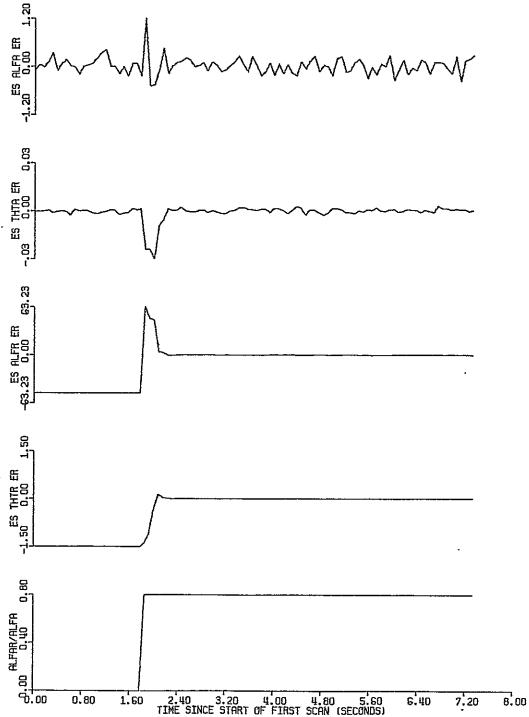


SCENARIO: ACOSITN3, PMLS1, BMLS=1.0 DEG, DELT= .0740741 SEC, KM=100, KSTART= 26 S/N= 40.0 DB, RHO= .8, BETA= 45.0 DEG,FSC=, .600 HZ, THESEP= 2.000 DEG RECEIVER: OPTIML, ADAPTIV, UNTETHAD, POPTI, BRCVR= 1.0 DEG INTERFERENCE TRACKER IDLER VALUES: .5, 1.5 DEG, 0.0 DEG/SEC, 90.0 DEG, 0.0 HZ BETA ESTIMATE ERROR: INITIAL= -45.0 ,FINAL= 5.61 DEG FSC ESTIMATE ERROR: INITIAL= .600 ,FINAL= -.118 HZ

Figure 3.13 Interference Acquisition, OPTRVR, S/N=40db, ρ =0.8 $\theta_{sep}^{=20}$, β =45°, $F_{sc}^{=0.6 \rm Hz}$

SIM. JOB: HUGHOTE FILE NO: 512211U303 ORTE: 04/03/79





SCENARIO: ACOSITN3, PMLS1, BMLS= 1.0 DEG, DELT= .0740741 SEC, KM=100, KSTART= 26
S/N= 40.0 DB, RHO= .8, BETA= 45.0 DEG,FSC=, .600 HZ, THESEP= 3.000 DEG
RECEIVER: OPTIML, ADAPTIV, UNTETHAD, POPTI, BRCVR= 1.0 DEG
INTERFERENCE TRACKER IDLER VALUES: .5, 1.5 DEG, 0.0 DEG/SEC, 90.0 DEG, 0.0 HZ
BETA ESTIMATE ERROR: INITIAL= .45.0 ,FINAL= .2.47 DEG
FSC ESTIMATE ERROR: INITIAL= .600 ,FINAL= .946E-01HZ

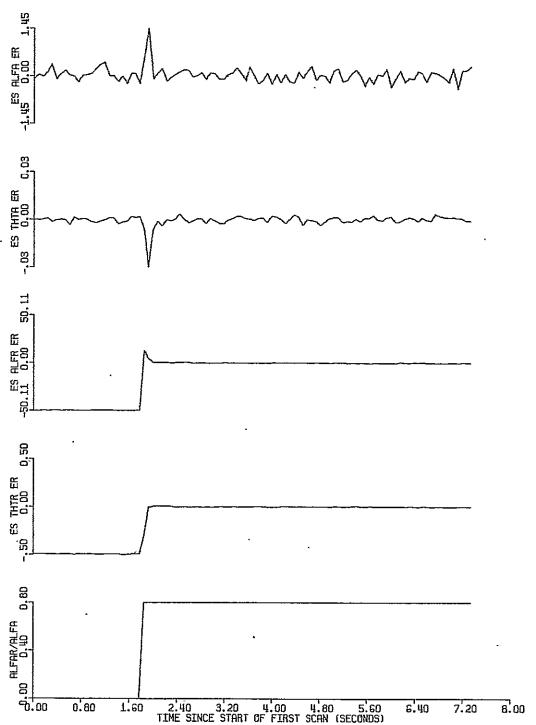
Figure 3.14 Interference Acquisition, OPTRVR, S/N=40db, $\rho{=}0.8$ $\theta_{\mbox{sep}}{=}3^{\mbox{o}},~\beta{=}45^{\mbox{o}},~F_{\mbox{sc}}{=}0.6\mbox{Hz}$

PLOT JOB: HUCHOM1

PROGRAM: ACOMP1

DATE: 04/03/79



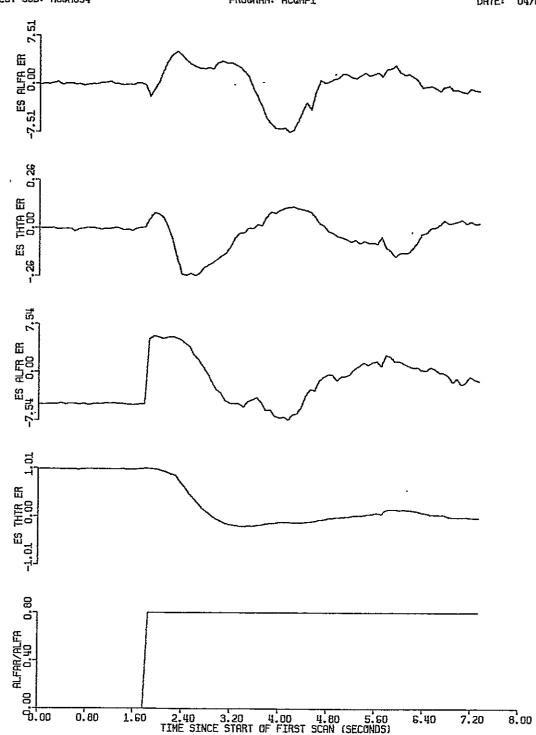


SCENARIO: ACOSITN3, PMLS1, BMLS= 1.0 DEG, DELT= .0740741 SEC, KM=100, KSTART= 26 S/N= 40.0 DB, RHG= .8, BETA= 45.0 DEG,FSC=, 2.500 HZ, THESEP= 2.000 DEG RECEIVER: OPTIML, ADAPTIV, UNTETHRD, PGPT1, BRCVR= 1.0 DEG INTERFERENCE TRACKER IDLER VALUES: .5, 1.5 DEG, 0.0 DEG/SEC, 90.0 DEG, 0.0 HZ BETA ESTIMATE ERROR: INITIAL= -45.0 ,FINAL= 4.97 DEG FSC ESTIMATE ERROR: INITIAL= 2.50 ,FINAL= .203 HZ

Figure 3.15 Interference Acquisition, OPTRVR, S/N=40db, $\rho=0.8$, $\theta_{\text{sep}}=2^{\text{O}},~\beta=45^{\text{O}},~F_{\text{sc}}=2.5\text{Hz}$

 SIM. JOB: HUCHOTR
 FILE NO: 512211U304
 DATE: 04/03/79

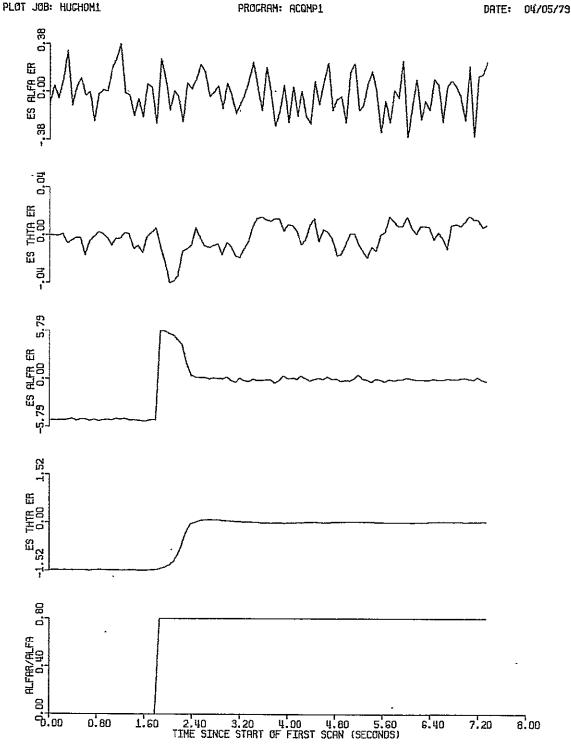
 PLOT JOB: HUCHO34
 PROGRAM: RCQMP1
 DATE: 04/05/79



SCENARIO: ACOSITN3, PMLS1, BMLS= 1.0 DEG, DELT= .0740741 SEC, KM=100, KSTART= 26 S/N= 20.0 DB, RHO= .8, BETA= 45.0 DEG,FSC=, .600 HZ, THESEP= .500 DEG RECEIVER: OPTIML, ADAPTIV, UNTETHRD, POPT1, BRCVR= 1.0 DEG INTERFERENCE TRACKER IDLER VALUES: .5, 1.5 DEG, 0.0 DEG/SEC, 90.0 DEG, 0.0 HZ BETA ESTIMATE ERROR: INITIAL= -45.0 ,FINAL= -2.98 DEG FSC ESTIMATE ERROR: INITIAL= .600 ,FINAL= .124 HZ

Figure 3.16 Interference Acquisition, OPTRVR, S/N=20db, ρ =0.8, θ_{sep} =0.5°, β =45°, F_{sc} =0.6Hz

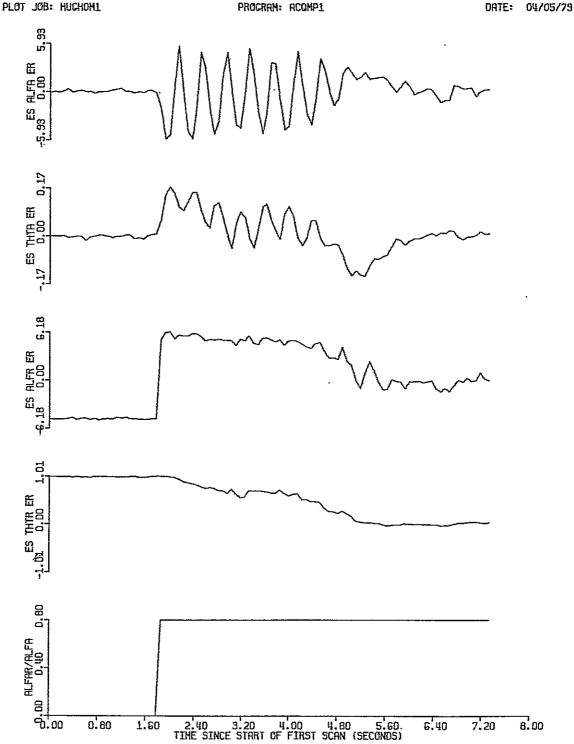
SIM. JOB: HUCHOTE FILE NO: 512211U305 DATE: 04/03/79



SCENARIG: ACQSITN3, PMLS1, BMLS= 1.0 DEG, DELT= .0740741 SEC, KM=100, KSTART= 26 S/N= 20.0 DB, RHG= .8, BETA= 45.0 DEG,FSC=, .600 HZ, THESEP= 3.000 DEG RECEIVER: OPTIML, ADAPTIV, UNTETHRD, POPT1, BRCVR= 1.0 DEG INTERFERENCE TRACKER IDLER VALUES: .5, 1.5 DEG, 0.0 DEG/SEC, 90.0 DEG, 0.0 HZ BETA ESTIMATE ERROR: INITIAL= -45.0 ,FINAL= 6.88 DEG FSC ESTIMATE ERROR: INITIAL= .600 ,FINAL= .174 HZ

Figure 3.17 Interference Acquisition, OPTRVR, S/N=20db, ρ =0.8, $\theta_{sep}^{=3}$, β =45, $F_{sc}^{=0.6Hz}$

SIN. JOB: HUGHOVC FILE NO: 512211U308 DRTE: 04/03/79

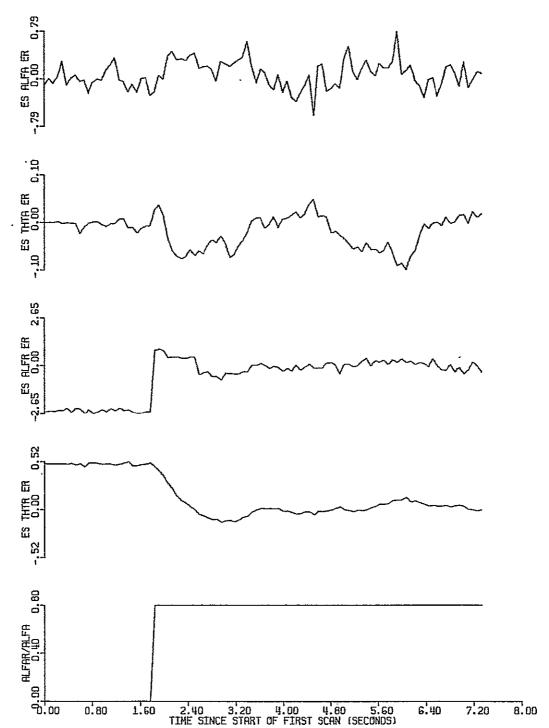


SCENARIO: ACQSITN3, PMLS1, BMLS= 1.0 DEG, DELT= .0740741 SEC, KM=100, KSTART= 26 S/N= 20.0 DB, RHO= .8, BETA= 45.0 DEG,FSC=, 2.500 HZ, THESEP= .500 DEG RECEIVER: OPTIML, ADAPTIV, UNTETHRD, POPTI, BRCVR= 1.0 DEG INTERFERENCE TRACKER IDLER VALUES: .5, 1.5 DEG, 0.0 DEG/SEC, 90.0 DEG, 0.0 HZ BETA ESTIMATE ERROR: INITIAL= -45.0 ,FINAL= -10.4 DEG FSC ESTIMATE ERROR: INITIAL= 2.50 ,FINAL= -.257 HZ

Figure 3.18 Interference Acquisition, OPTRVR, S/N=20db, ρ =0.8, θ sep =0.5°, β =45°, F_{sc} =2.5Hz

SIM. JOB: HUCHOUR FILE NO: 512211U3OS DATE: 04/03/79

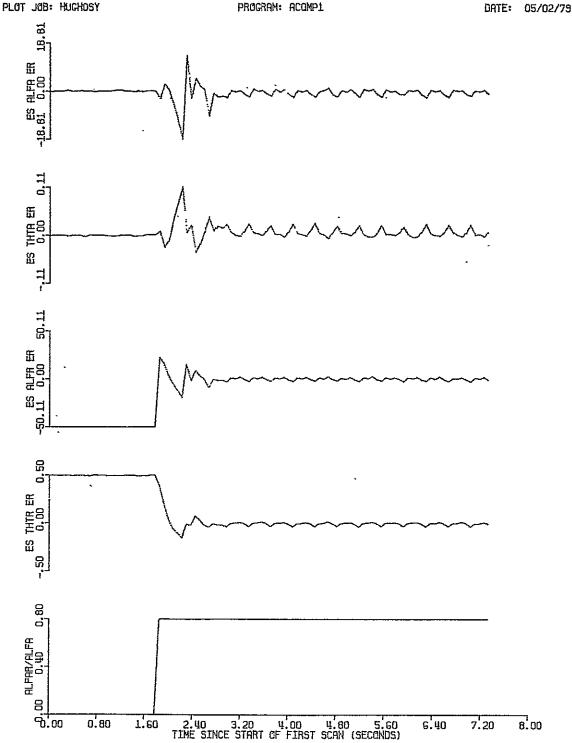
PLOT JOB: HUCHOM1 PROCRAM: ACOMP1 DATE: 04/05/79



SCENARIG: ACQSITN3, PMLS1, BMLS= 1.0 DEG, DELT= .0740741 SEC, KM=100, KSTART= 26 S/N= 14.0 DB, RHG= .8, BETA= 45.0 DEG,FSC=, .600 HZ, THESEP= 1.000 DEG RECEIVER: OPTIML, ADAPTIV, UNTETHRD, POPTI, BRCVR= 1.0 DEG INTERFERENCE TRACKER IDLER VALUES: .5, 1.5 DEG, 0.0 DEG/SEC, 90.0 DEG, 0.0 HZ BETA ESTIMATE ERROR: INITIAL= -45.0 ,FINAL= -1.64 DEG FSC ESTIMATE ERROR: INITIAL= .600 ,FINAL= -.482E-01HZ

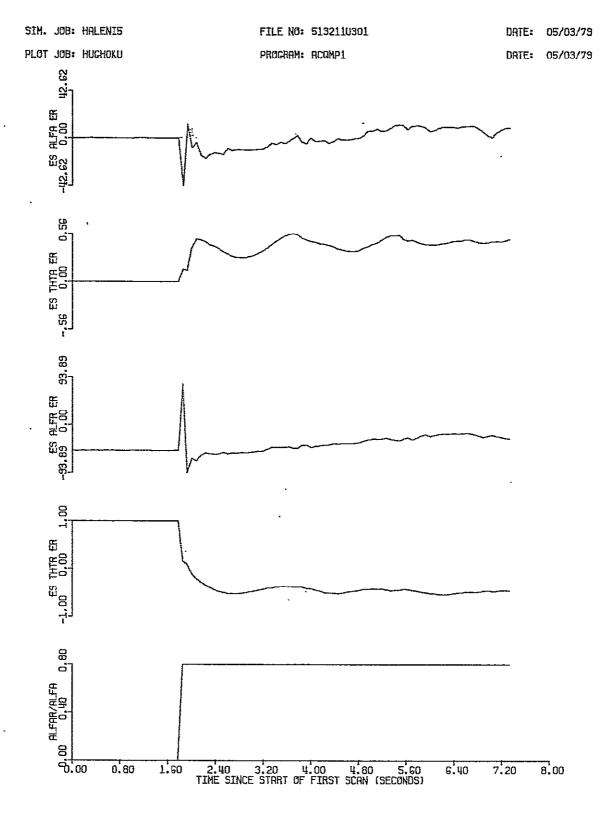
Figure 3.19 Interference Acquisition, OPTRVR, S/N=14db, ρ =0.8, θ_{sep} =10, β =450, F_{sc} =0.6Hz

SIM. JOB: HALENPY FILE NO: 512211U309 DATE: 05/02/79



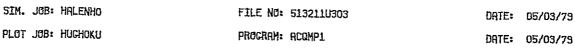
SCENARIO: ACOSITN3, PMLS1, BMLS= 1.0 DEC, DELT= .0740741 SEC, KM=100, KSTART= 26 S/N= 40.0 DB, RHO= .8, BETR=-168.0 DEC,FSC=, 51.300 HZ, THESEP= 1.000 DEC RECEIVER: OPTIML, ADAPTLY, UNTETHRD, POPTL, BRCVR= 1.0 DEC INTERFERENCE TRACKER IDLER VALUES: .5, 1.5 DEC, 0.0 DEC/SEC, 90.0 DEC, 0.0 HZ BETA ESTIMATE ERROR: INITIAL= 78.0 ,FINAL= 5.11 PEC FSC ESTIMATE ERROR: INITIAL= 51.3 ,FINAL= 50.6 HZ

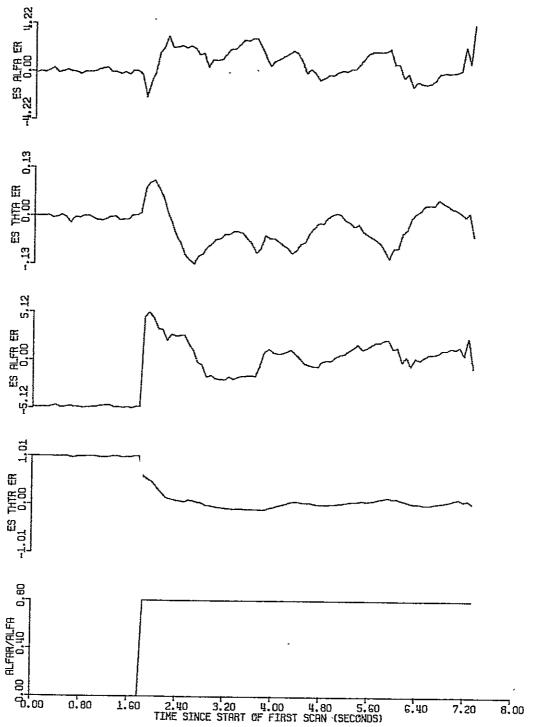
Figure 3.20 Interference Acquisition, OPTRVR, S/N=40db, $\rho{=}0.8$ $\theta_{\mbox{sep}}{=}1^{\mbox{O}},~\beta{=}-168^{\mbox{O}},~F_{\mbox{sc}}{=}51.3\mbox{Hz}$



SCENRRIG: ACQSITN3, PMLS1, BMLS= 1.0 DEG, DELT= .0740741 SEC, KM=100, KSTRRT= 26 S/N= 40.0 DB, RHO= .8, BETA= 45.0 DEG,FSC=, .600 HZ, THESEP= .500 DEG RECEIVER: SUBOPT, ADAPTIV, UNTETHRO, POPTI, BRCVR= 1.0 DEG

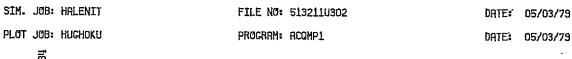
Figure 3.21 Interference Acquisition, SUBOPT, S/N=40db, ρ =0.8, θ_{sep} =0.5°, β =45°, F_{sc} =0.6Hz

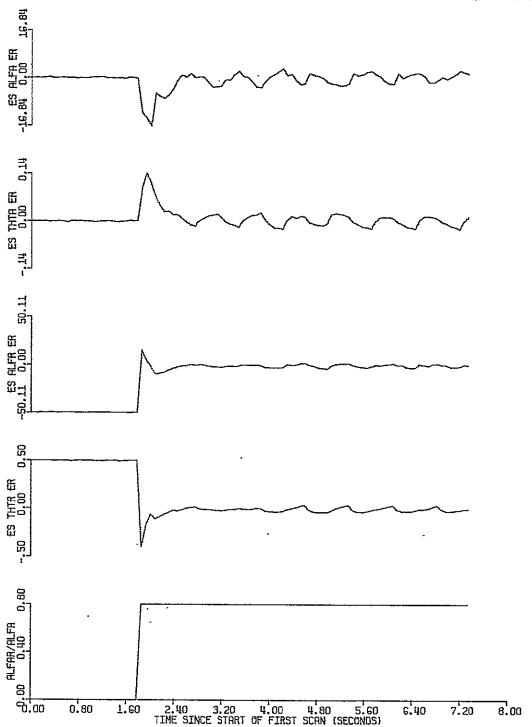




SCENARIO: ACQSITN3, PMLS1, BMLS= 1.0 DEG, DELT= .0740741 SEC, KM=100, KSTRRT= 26 S/N= 20.0 DB, RHO= .8, BETA= 45.0 DEG,FSC=, .600 HZ, THESEP= .500 DEG RECEIVER: SUBOPT, ADAPTIV, UNTETHRD, POPT1, BRCVR= 1.0 DEG

Figure 3.22 Interference Acquisition, SUBOPT, S/N=20db, $\rho=0.8$, $\theta_{\text{sep}}=0.5^{\circ}$, $\beta=45^{\circ}$, $F_{\text{sc}}=0.6$ Hz





SCENARIO: ACQSITN3, PMLS1, BMLS= 1.0 DEG, DELT= .0740741 SEC, KM=100, KSTRRT= 26 S/N= 40.0 DB, RHO= .8, BETA=-168.0 DEG,FSC=, 51.300 HZ, THESEP= 1.000 DEG RECEIVER: SUBOPT, ADAPTIV, UNTETHRD, POPT1, BRCVR= 1.0 DEG

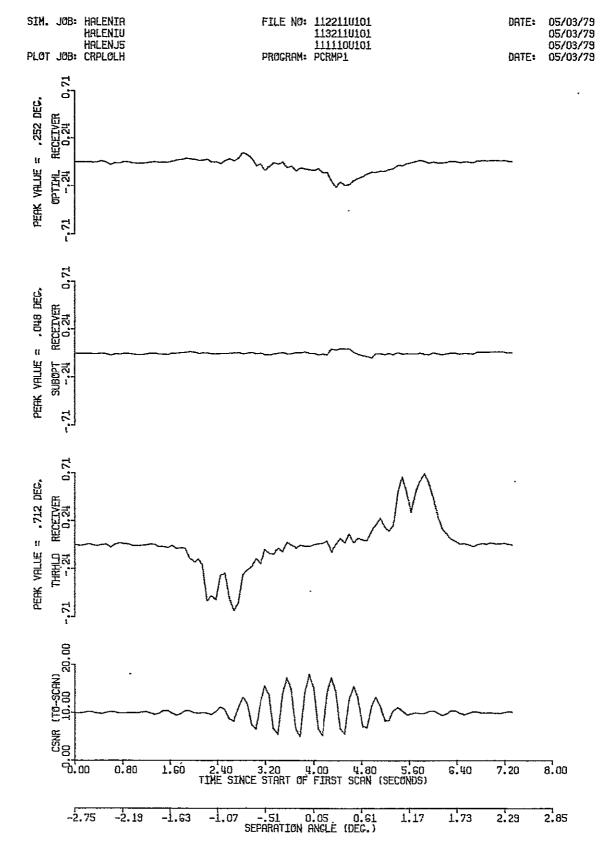
Figure 3.23 Interference Acquisition, SUBOPT, S/N=40db, ρ =0.8, θ sep =10, β = - 1680, 51.3 Hz

- a. S/N = 40 db -- unsuccessful pull-in, in fact loss of track of the direct path pulse (Figure 3.21);
- b. S/N = 20 db -- successful pull-in (Figure 3.22);
- 2. Successful pull-in @ S/N = 40 db, $\theta_{\rm sep}$ = 1° and F_{sc} in the 5th lobe, again maximum enhancement of TO pulse, maximum cancellation of FRO pulse (Figure 3.23).

The poor performance shown in Figure 3.21 is probably attributable to the low scalloping rate, the successful pull-in of Figure 3.22 notwith-standing. The SUBOPT design is essentially premised upon on arbitrarily high scalloping rate, and under these circumstances the results of . Figure 3.21 are probably more to be expected that those of Figure 3.22. The successful pull-in of Figures 3.22 is probably only a testament to the beneficial effects of noise acting as dither; or worse, it may be sample function dependent. More study here should be done.

Finally, Figures 3.24 and 3.25 provide comparisons of the three receivers OPTRVR, SUBOPT and the threshold receiver, in a crossing multipath scenario, beginning with the receivers in track and the interference initially out-of-beam. The same noise sample function was used to construct the envelope signal applied to the receiver in each case, and the error time histories are all plotted to the same scale. Two significant differences in the figures, one intentional, one not, are, as follows:

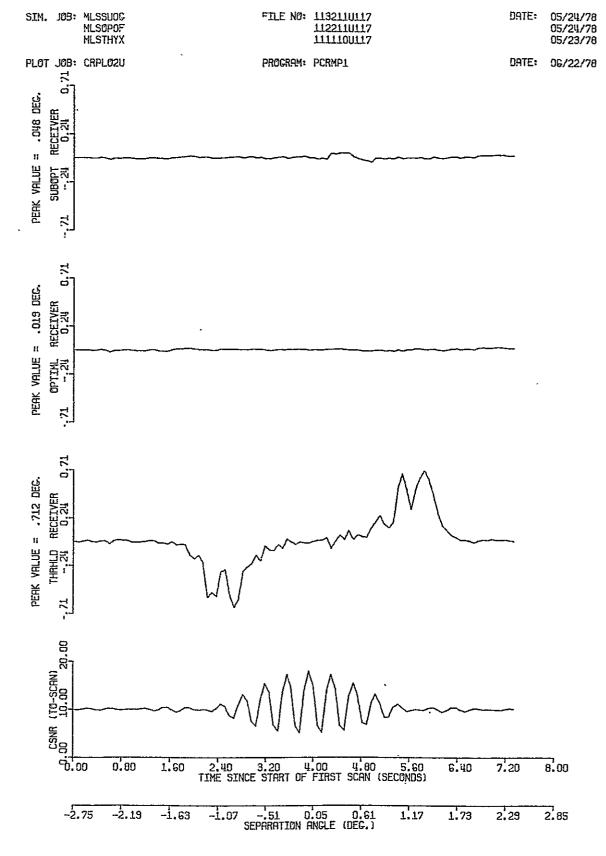
- 1. In Figure 3.24, the OPTRVR and SUBOPT designs include constraints, in Figure 3.25 these are without constraints.
- 2. In the two figures that OPTRVR and SUBOPT error time history traces are interposed; in Figures 3.24, that for OPTRVR is on top; in Figure 3.25, that for SUBOPT is on top.



S/N= 20.0 DB, RHO= .80, BETA=-168.0 DEG, FSC= 51.3 HZ, KM= 100 SCANS, BMLS= 1.00, PMLS1

OPTIML: ADAPTIV, UNTETHRD, POPTI, BRCYR=1.00 DEG., ERMS= .690944E-01 DEG. SUBOPT: ADAPTIV, UNTETHRD, POPTI, BRCYR=1.00 DEG., ERMS= .136560E-01 DEG. THRHLD: -3 DB , UNTETHRD, 6.00% OF SCANS ABORTED, ERMS= .243510 DEG.

Figure 3.24 Crossing Multipath, OPTRVR and SUBOPT with constraints S/N=20db, ρ =0.8, β = - 168, F_{sc} = 51.3 Hz



S/N= 20.0 DB, RHO= .80, BETA=-168.0 DEC, FSC= 51.3 HZ, KM= 100 SCRNS, BMLS= 1.00, PMLS1

Figure 3.25 Crossing Multipath, OPTRVR and SUBOPT without constraints S/N=20db, ρ =0.8, β = - 168°, F_{sc} = 51.3 Hz

Another very significant difference is in the OPTRVR error time histories themselves — that without constraints peaks at about 1/50°, and that with constraints, at about $\frac{1}{4}$ °, worse than the SUBOPT response, which peaks at about 1/20° with and without constraints. Again, we suspect the \hat{w}_{SC} constraint for the deterioration of the OPTRVR performance. Nevertheless, all optimal structure receivers performed better in this demonstration than did the threshold receiver, which peaked at 0.71°. The lowest trace shows the carrier signal-to-noise ratio CSNR, evaluated at the peak of the direct path pulse on the TO-scan, as the simulation evolves. The F_{SC} used here is in the 5th lobe, the exact β , F_{SC} , values used being again that combination producing maximum enhancement of the TO-pulse and maximum cancellation of the FRO-pulse at crossover.

In summary, a simulation study involving principally statistical error studies but also some error time histories has been carried out; a substantial collection of FORTRAN programs was developed. Simulation results show for the OPTRVR design

- RMSE performance improvement factors wrt the threshold receiver sometimes approaching 30 at 20 db S/N;
- Full track capability limited to scalloping rates below ½ of rep. rate (below 6.75 Hz in AZ).
- 3. Some deterioration in performance when constraints are used believed attributable to the \hat{w}_{SC} constraint. Removal of this one constraint may restore the generally higher RMSE performance of the unconstrained OPTRVR without reducing the resistance to loss of track apparently characterizing the constrained receiver (see SUBOPT below). Also perhaps a depend-

able angle-tracking capability at higher scalloping rates might result from removal of the \hat{w}_{sc} -constraint.

The results show for the SUBOPT design

- Lesser performance than the OPTRVR design, improvement factors wrt the threshold receiver sometimes approaching 15 at 20 db S/N;
- Performance probably better at higher scalloping rates, deteriorating at lower rates;
- 3. Very definite improvement in track-holding ability at small separation angles when the receiver constraints are applied. There is no \mathbf{w}_{sc} -estiamte, hence no $\hat{\mathbf{w}}_{sc}$ -constraint in the SUBOPT design.

Based on studies of the OPTRVR, we expect both the OPTRVR and SUBOPT design performance to be quite sensitive to error, in the receiver model, of the transmitting antenna selectivity function, particularly the beam width parameter. Possible approaches to reduce the effects on performance were discussed. Finally, in error time history studies

- 1. Strong interference pull-in capabilities at various S/N's and F_{sc} 's were demonstrated, which might be used in an interference acquisition scheme; and
- 2. A high performance in a representative crossing multipath situation was demonstrated, and is to be generally expected, particularly if the removal of the \hat{w}_{sc} -constraint will have the effects expected and discussed.

SECTION IV

EXPERIMENTAL SYSTEM CONSIDERATIONS

An experimental receiver development project was included in the original research proposal and begun in 1976 in parallel with tracking algorithm development then in progress. The project was short-lived, however, and abandoned the following year, principally because the computational demands of the evolving tracking algorithms simply could not be met with any economically feasible microcomputer that was available at the time. The general design philosophy and the allocation of tasks among

- 1. the interface hardware
- 2. the foreground software
- 3. the background software

were described in [3, pp. 52-60]; the approach to the interface design, involving specifically a state controller, is conveyed in Appendix B of this final report.

At the present time, both the MLS tracking algorithm development and the state-of-the-art in microcomputing are more advanced. It seems safe to conjecture, in conclusion, that one way the requisite computer power might be obtained economically, certainly in the near future, is to make use of a bank, or an array, of now diminishingly expensive microprocessors. One or more microprocessors might serve the executive function, allocating the resources provided by the others to the various computational needs as they arise. Advantages of such an arrangement might be, as follows:

- 1. It would be able to exploit the large potential for parallel computation in the tracking receiver calculations;
- 2. It would have high protection against total system failure due to isolated failures;
- 3. It would easily accomodate the randomized repetition rates in the MLS.

SECTION V

SUMMARY AND CONCLUSIONS

This report has described research performed at the University and concerned with optimal MLS receiver theory, design and simulation evaluation. The program has produced a general receiver structure which, it is believed, gives close to limiting performance; it consists of a Scan Data Processor (SDP) based on the theory of Locally Optimum Estimation enclosed in a Tracking Loop Filter (TLF) based on MMSE recursive state estimation. Three concrete specializations of the general structure were carried out, characterized by both the dimension of the Scan Data Processor and the method of extraction of phase difference (β) and scalloping frequency (w_{SC}) information, as follows:

- $\underline{5D\ SDP}$: Denoted the Optimal design (OPTRVR); SDP extracts β information from each scan; TLF extracts w_{sc} information from the sequence of scans;
- 4D SDP: Denoted the Suboptimal design (SUBOPT); Both β and ψ sc are suppressed from the model and not estimated,
- 6D SDP: Denoted the 6D LOE design; SDP extracts β and w information from each scan; TLF may optionally extract \dot{w} sc information.

Two of these, the OPTRVR and SUBOPT designs were studied extensively in simulation studies, including:

- a. Statistical error studies under various conditions;
- Studies of interference acquisition capability using "pull-in",

c. Performance evaluations with "crossing" multipath interference.

and comparisons of performances were made with a simulated "threshold" receiver approximately representative of the Phase III design. Finally, a limited effort to implement an experimental receiver was undertaken, but was aborted with little more result than the tentative approach planned and the insights gained.

In the simulation studies of RMSE the OPTRVR and SUBOPT designs showed improvements over the threshold receiver by factors approaching 30 and 15, respectively, at low scalloping rates. Constraints were imposed on the computed estimates, based largely on natural limitations on the true state values, and as a result, improved ability to maintain track was noted in the SUBOPT design at small separation angles and moderate S/N. At higher values of scalloping rate, w_{sc} , the SUBOPT design was superior to the OPTRVR with constraints. The data suggests, however, that the $\hat{\boldsymbol{\omega}}_{_{\mathrm{SC}}}\text{-constraint}$ in OPTRVR may be hurting performance some, though even with its removal, successful full-state tracking can't be expected in OPTRVR in the strict sense at higher scalloping frequencies. A high sensitivity to error in the receiver model of the MLS transmitting antenna selectivity function, particularly the beam width parameter, was observed in the SUBOPT design (and believed to be characteristic of the OPTRVR design also). Approaches were discussed to reduce this problem. Both the OPTRVR and SUBOPT designs exhibited sufficient multipath "pull-in" capability to merit a "pull-in" approach to interference acquisition. In summary, the receiver designs developed in this research have demonstrated in simulation superior levels of performance for MLS receivers. Some areas of consideration need further study, however, to fine-tune the designs to the signal and state dynamics environment and other aspects of the application. On the basis of available data the SUBOPT design appears to be the more appropriate for the MLS aircraft receiver application, where the scalloping rates experienced are generally greater than one-half the MLS angle function repetition rate, and thus beyond the full-track capability of the OPTRVR design.

From the viewpoint of implementation, it would appear that, on the basis of trends in the microprocessor art,

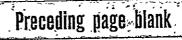
- Input of the envelope samples to the computer should be made by direct memory access (DMA), and
- 2. The comptuer should, perhaps, be a bank of microprocessors performing many operations in parallel (to supply the requisite computing power) and operating as a unified system under an executive function microprocessor.

Finally, an operational receiver should probably be structurally adaptive also with an ability to expand the state vector (by appending a "sentry" tracker channel tethered to "idler" values) as additional interference pulses are recognized and acquired. The "sentry" should move from a position one side of the sampling window to the opposite side and then back on alternate scans to preserve the integrity of the main pulse track. Also when the separation angle for an interference pulse drops below a certain threshold and information needed to distinguish the pulse becomes less available, track of that interference pulse should then be dropped and the state dimension suitably decremented.

PRESENTED FACE BLANK NOT BUILD.

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APPENDIX A

COMPUTER PROGRAMS

Programs in this appendix are listed below in the order presented, generally alphabetized by Module name in two groups. Programs within each Module are listed with a brief characterization of the Module.

Programs for the 6D LOE design are given in Appendix C.

SIMULATION PROGRAMS

CTLACQN3: CONTRL, Interference Acquisition Scenario

CTLCRMP: CONTRL, Crossing Multipath Scenario

CTLMSBB1: CONTRL, RMSE (Bratio)

CTLMSFS1: CONTRL, RMSE (F_{sc}) .

CTLMSFS2: CONTRL, RMSE (F_{sc}) , $(\hat{\beta}, \hat{\omega}_{sc})$ tethered to $(\pi/2, 0)$

CTLMSTH2: CONTRL, RMSE (θ _{sep}), averaging with F_{sc} $\neq 0$ CTLOE: CONTRL, RMSE (θ), averaging with F = 0

CTLOE: CONTRL, RMSE (θ_{sep}) , averaging with F =0 MLSSIM: MLSSIM, MLSSUB, THA, DFLTR1, MLS

OPTRNC: 'RCVR, ORVRID, No constraints, except on β

OPTRVR: RCVR, ORVRID, with constraints

PLSUB: PHILM, WAWBJ, SWFCNS, PLUSID, Suboptimal SDP

PLOPT: PHILM, PLOPID, Optimal SDP

PMLS1: PMLS, PMLSID, p-function used in generating signal POPT1: P, PDOT, POPTID, p-function presumed in receiver

THDRVR: RCVR, TRVRID, threshold receiver

UTILITY AND SERVICE PROGRAMS

ACQMP1: ACQMP1, Acquisition plot generator

LABLIB: CLIP, GAUSS, INTIO, LOGIO, MATIN, MATMUL, MATOUT, MATSM,

MULPLT, PLOTR, PVALUE, REALIO, RETURN, SATU, library

of utility routines

PCRMP1: PCRMP1, Crossing multipath plot generator

RLOGSW: RLOGSW, Reads and lists out SWAJ, SWBJ, & RABJ data

from file

WLOGSW: WLOGSW, WAWB, WAVGS, computes SWAJ, SWBJ, & RABJ data

and writes files

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	COMMON/MLSU04/BMLS, BBB, MTIMES, MSET, MORE				
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		-I,(I)7UGTAD S wattes nut	PUT FILE , 2A10	11				
	L' DATE(TODA							
		FUNCTH (IAE)			•			
	MAT (1H0,A7:)=X0(4,IAE):		N (IAE=, 11,1H)	1) " '''	•			
		-0. ({I,X{I}},I=	1,8)		-			
260 FOR	MAT (15HOIN:	ITIAL STATE:	//(3H X(,11,4H	() = +G13+6))				
WRI	TE (7, 270) TE							
270 FOR	MAT(1HO,A7)							

SUBROUTIN	C CONT	RL 73/172 TS		FTN 4.6+452	05	/17/79	17.25.29	PAGE	5
	900	CONTINUE							
230	IHT D	S SAVES/PREPROCESSES	DATA FROM THE K-TH	SCAN			•		
		THERR=X(2)-XS(2)	•						
		OTHE *X(2)-X(5) COLb=SQRT(PPOIAG(2))							
		DO 910 1-1,NS							
235		ES(1)=X(1)-XS(1)		•					
		KMSVAL(I)=SQRT(PPDIA	(G([})	•	-	••		ч	
- •	910			-1.					
		IF (NS.GE.7) ES(7) = IF (NS.GE.8) ES(8) =	. WD2 (V(1)1—WB2 (V2)	/// 811					
240	** ***	SCANNR (K) + K		7 No ma not 100 to 100 to			-		•
		EALFA(K)=ES(1)							
, , ,	•	£THET(K)=ES(2)		•		•	• •		
		EALFR(K)=ES(4) ETHER(K)=ES(5)							
245		XFOUR(K)=X(4)/X(1)							
		IF (NS.LE.6) GO TO 9	15						
		E8ETA(K)=180.+ES(7)/							
	915	EFSC(K)=0.5+ES(8)/PI	į.			•			•
250	723	WRITE (7,920) K,	CSNRT, CSNRF, 1HX, (Y(1)-T=1-81					
	920	FORMAT(1H ,13,	2(1X,G10,3),8X,A	1.1X.8(1X.G10.3))					
1 - t = 1	• -	WRITE (7,930) 7H	x2 \ (x2 (1) \ 1 = 1 \ N2 \		<u> </u>	-		1	
		WRITE (7,930) 7H	ERR, (ES(I), I=1, NS)						
255	930	WRITE (7,930) 7HSQ(P FORMAT (1H,27X,A7,1	'111;(KM5VAL(1);1=1 Y.8(1Y.G1D.3))	, NS 1		•			
						: . ;			
		RETURN				, X	in En		
	C .					77. 2	3		
. 260	0	*********	·	********	******		ek 1		
	•	CONTINUE				X.	<i>*</i> **	'	
		S SAVES/PROCESSES/OUT	PUTS DATA FROM THE	(LG)-TH SET OF KM	SCANS " -		<u> </u>		
		WRITE(7,1060) (GOGT([I,I),I=1,NS)					_	
265		FORMAT (10(/),35H ON *1H ,G11.4,7(1H,,G11.		AL DE GOGT WAS		- 11		•	
207		YHIN=YHAX=O-"" "		4 br =					
		WRITE (7,11)							
	** ,	CALL PLOTRISCANNE, E		1,YMIN,YMAX,O;	_	**	• • •		
		AINY MODULLARA LACT XANYHOLDIDAR REALLOC	(PMINAL)						
210		YMIN=YMAX=O.	() [MAX91]					•	
4 P P / M M M M M M M M M M M M M M M M M		WRITE (7,11)					10m 1		
		CALL PLUTR(SCANNR, E		CO.XAMY.NIMY.S					
276		"CALL REALIDIGH YMIN		•	•			,	
		CALL REALID(6H YMAX 'YMIN=YMAXEO	(THAX + L)						
		WRITE (7,11)							
		CALL PLOTR (SCANNR, E	ALFR, KM, XNAME, YNAM	S.XAMY.NIMY.E	• 1 •	•			
200		CALL REALID(6H YMIN	(,YMIN,1)						
280	-	CALL REALID(6H TYMA)	C. THAX'S I'M	-· ·	•			•	
		YMIN=YMAX=0. "WRITE'(7,11)"				******			
		CALL PLUTRISCANNE, E	THER, KM, XNAME, YNAM	4.YHIN.YHAX.O)					
		CALL REALIGIOH YMIN	(• YMIN•I)						
285		CALL REALID(6H YMA)	(,YMAX,1)	NAM 1					
•	•			Maria 1 111					

SUBRUUTINE CONTRL	73/172 TS	FTN 4.6+452	05/17/79 17.25.29	PAGE	6
	of any transfer of the first				
V4.1					
	IN * YMAX = C.		• •		
	ITE (7,11)	WE VUTU VUIV AL			
	L PLUTRISCANNR, XFOUR, KH, XNAME, YNA	US TUT KAUL CUTUL CEU			
296 CAL	L REALID(6H YMIN, YMIN, 1)				
	L REALIG(6H YMAX, YMAX, 1)				
7.4 1.01	(TE (7,11)				
	. O = XAHY = N			, 	
CAL	L PLOTR(SCANNR, EBETA, KM, XNAME, YNAM	7. YHTN. Y X X Y . O.)			
- 295 CAL	L REALIG(6H YMIN, YMIN, 1)				
	L REALIGIOH YMAX, YMAX, 1)				
YKI	N=YMAX=O.		* . *		
	TE (7, 11)				
	L PLOTR(SCANNR, EFSC, KM, XNAME, YNAM8	. YHIN. YHAX. O)			
	L REALID(6H YMIN, YMIN, 1)				
	L REALIG(6H YMAX, YMAX, 1)				
1065 CDN	ITINUE				
IF(.NOT.FILOUT) RETURN	. , , , , , , , , , , , , , , , , , , ,			•
	(TE(7,11)		1		
305 WR1	TE(7,1070) (DATOUT(1),1=1,2)		•	-	
	RMAT(13H OUTPUT FILE ,2A10,1H:/)	•		-	
	LTE(7,1072) DOUT, DELT, MTIMES, LGMAX,				
	MAT(1H ,A10,8X,G13.6,5X,3(5X,13,10	X),A10,8X,A10/)	At 17 mm aframed on virtual and a sec		
	Te(7,1074) IDENTS, KSTART				
	RMAT(1H ,6(1X,AB,9X),13/)		0 9		
	TE(7,1076) NRUN, DSNROB, RHO, BETA, FS	C, BMLS, BRCVR, THESEP	名養		
1076 FUR	MAT(1H ,12,3X,7(3X,G12.6)/)				
	(=MINO(35,KM-9)		POOL		
	1077 I=1, IKM	TA PRIJEDATA MEMINATA **	management with the same of th	•	
	TE(7,1078)EALFA(1),ETHET(1),EALFR(I) JEIHEK(I) JAPOUK(I)	3 5		
	1MAT(1H ,5(G13.6,5X)) 1G79 I=1,5				
	TE(7,1080)		₽ 3	•	
	MAT(1H,5(6X,1H,,11X))			•	
	3=KM-3		2.55		
	1081 I=KM3,KM		- 1 - 1		
	TE(7,1078) EALFA(I), ETHET(I), EALFR(IleETHER(I).XFOUR(I)	772		
T. WRI	TE(7,1063)RHOMAX, OTHO, TORO, BETAO, F	SCO, EBETAD, EBETA(KM), EFSC	O		
	SC(KM)				
1 325 "'1G83 FOR	RMAT (1H0,9(G12.6,2X)) " " "	н •			
WRI	(TE(17) DOUT, DELT, MTIMES, LGMAX, KM, T	DDAY, JBNAM			
WRI	(IE(LY) IDENTS,KSTART			•	•
WR I	(TE(17) NRUN, DSNROB, RHO, BETA, FSC, BH	LS, BRCVR, THESEP			
	1090 I=1,KM		•		
33C WRI	[TE(17) EALFA(I), ETHET(I), EALFR(I),	ETHER(I), XFOUR(I)			
	TINUE " '				·
	(TE(17) RHOMAX, OTHO, TORO, BETAO, ESCO.	EBETAO, EBETA(KM), EFSCO, E	FSC(,	
CKM)					
	VIND 17		4		
	·IATTACH(6LTAPE20,DATOUT)				
	LL RETURN(6LTAPE2G)	u ==	-		
	(IX.NE.O) GO TO 1095" """"	35711 - 3100 - 3451			
AAT AAT AAT AAT	·ICATALO(6LTAPE17, DATOUT, 2LPW, 8RHIG TO 1096	3FALL92LKF93031		-	
	:ICATALO(6LTAPE17,DATOUT,2LXR,8RHIG	4FT11.2100.3A51			
1096 IF	(IX.NE.G) CALL INTID(6HIX(CA),IX,1,	1 1			
	(IX.NE.O) STOP≠OUTPUT FILE CATALOG				
7.1	The state of the s		•		

2008901185	CUNIKL /3/1/2 13	FIN 4.0+432	05/1///4 1/•25•24	PAUE	ſ
	AR I D DECEMBED AND A SECOND OF THE SECOND O				
345	CALL RETURN(6LTAPE17) WRITE (7,1099) (DATOUT(I), I=1,2) 1099 FORMAT(13HCOUTPUT FILE , 2A10, 33H IS WRITTEL KETURN	N, CATALOGED AND CLOSE	D)		
	· (***********************				
	C	******			
350	1100 CONTINUE '				
	C THIS SAVES/PROCESSES/DUTPUTS DATA FROM THE (MS	ET)-TH SERIES OF			
	CLGMAX SETS OF KM SCANS"				•
	C ` ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' '		1 W - 1-1-1		•••
355	C********************************	*********			
	1250 CONTINUE				
	C THIS EFFECTS CLOSURE OF THE SIMULATION RUN				•
	WRITE (7,11)				
360	RETURN TO THE TOTAL TOTAL		4 L 10 2000000000000000000000000000000000		•
	C+++++++++++++++++++++++++++++++++++++	*******			
	C .				
	TO TEND TO THE TOTAL TO A TOTAL AND A TOTA				
	4110				
440JOB CHTSTORAG	E USED 6-147 SECONDS			begins - Av + 4	٠

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**************************************	CURRENTAL CONTRACTOR		~~, ~~ ~~ ~~ ~~		
	SUBROUTINE CONTRL(ISW)				
		1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2			
	HIS CONDUCTS THE HLS SIMULATION THROUGH	H A			
_ "	OSSING HULTIPATH SCENARIO	B 01 1422	**		•
5 C					
	TREAL LANDA				
	INTEGER XNAME(2), YNAME(2), DATIN(4), D	ATOUT(4),DOUT			
1 - TF	INTEGER TITLE1(3), TITLE2(2,2), FUNCTN	(2)	•• •		
	LOGICAL NOKLHNANOLDE, NOAC, KALHANALDE,	TETHRO, MORE, NEIRST, ADAPTV			
10	COMMON/IDDATA/ISIM, IPHLS, IRCVR, IADAP		7 * m *		
	COMMON/RCVROO/THAHAX, THAHIN, TS, TR, DM				
	COMMON/RCVR01/NGMIN, NGMAX, DELBL, NGM,				
	COMMON/RCVROZ/RHOMAX, DTHO, TORO, BO, WS			•	
	COMMON/RCVRO3/PI,F(8,8),FL25(4),FSAM	PAKAKHATETHEDANGANGAIN '			
15	COMMON/RCVRO4/DELT, ED(8), GQGT(8,8), H	(B. St. TCOINT, CICHA			
	COMMON/RCVRO5/NOLDE, NOKLMN, NOAC, GAMAI				
	COMMON/RCVR06/PPDIAG(8),RMAT(5,5),PHI COMMON/RCVR07/T(130),V(130)	riapaipratopolicamua(5)			
	COMMON/RCVRO8/XSLOE(8), ESLOE(8), ES (8)	•		I .	
20					
	COMMON/RCVR09/BRCVR, BB, PDCRIT, CC	·		-	
	COMMON/RCVR10/XS1(8),XS(8)				
	COMMON/MLSOOO/ALFA, THE, THEDOT, ALFAR,				
	COMMON/MLSOOI/CSNRT, CSNRF, DSNRDB, RHO,	BETA, FSC, LGMAX			
~=	"COMMON/HLSOOZ/DCSNR, CSNR, LG, TPKT, TPK!				
2.5	COMMON/MLS003/FL10AE(4,2),FL10(4),DEL	.TAT(2),XO(8,2),YO(4,2)			
	COMMON/HLSOO4/BMLS, BBB, MTIMES, MSET, MC			•••	
	DIMENSION CONRTO(100), X(8), THESER (100)), THESEP(100), ABBORT(100)			
	- DIMENSION IDNRS(6), IDASCI(18), IDENTS				
'	EQUIVALENCE (ALFA, X(1)), (ISIM, IDNRS()				
- 30	"- DATA ABORT/1HA/,SPACE/1H /,NFIRST/.FA			W. W. All	**
	DATA DATIN/IOHHLSSIMDATA, 10H100000F00	00,2+0/			
	- DATA DATOUT/10HHLSSIMDATA,3*0/	P wil			
,	DATA IDASCI/7HCROSSMP,7HRMSE(T),7HRMS	SE(B), BH PMLS1 ,8H PMLS2	,		
	*8H PML\$3 ,8H THRHLD ,8H OPTIML ,8H S	SUBOPT >8H -3 DB >8HADAPT	IV ,		
35	*8HNONADAP , 8HUNTETHRD, 8HTETHERED, 2H	,8H POPT1 ,8H POPT2 ,			
	**** POPT3 "/ " " ' " "		44 % Paper 6 4		•
	DATA NSTART/15/, IRSIGN/1/				
	 DATA TITLE1/6H X(2) ,6HX2-X5 ,6HXS(2) 	· /	•	- 4-	
	DATA TITLE2/6HFIL ER,6HX2-XS2,6HX2-XS				
40	DATA FUNCTN/7HAZIMUTH, THELEVAT./	, ,		··· · · ·	
	DATA XNAME/8HTHETASEP,8HDEGREES /,YNA	ME/8HTHES ERR.8HDEGREES /			
		2004 May 100 4 2 10			
	GD TO (100,200,300,400,500,600,700,80	0.900.1000.1100.12001.TSU			
·· 1 ·	- FORMAT(1H)		· - · · · · · · · · · · · · · · ·	• •	
45 10	FORMAT(9(/))				
	FORMAT (1H1)	,		•	
Ē.	: =:	•			
	*********	******			
č	· · · · · · · · · · · · · · · · · · ·	·	r r	•	
50 100	CONTINUE				
		LTTER AC NEGROOLDY	•		
- CIH	IS IDENTIFIES THE SCENARIO AND REINITIA	LIZES, AS NECESSARY,			
	FOLLOWING RECEIVER PARAMETERS				
CSIG	MA, IAE, DSNRDB, RHD, FSC, BETA, JM, BMLS				
	TF(NFIRST) GO TO-155	- al yak.day birda. Milate) day			
55	NFIRST= • TRUE •				
	JBNAM=JOBNAME(I)	• • •			
	ISIM*1				

	E CONTR	RL ' 73/172 ' TS			FTN 4.6+452	05/18/	79 13.43.46	PAGE	2
		IMOD=1		*****			***************************************	, ,	,-
		WRITE (7,110) - "							•
. 60	110	FORMAT (28H1CROSSING-	MULTIPATH SCENAF	(10/)	, .			•	
	COLD	IX=IATTACH(6LTAPE15,D IF(IX.NE.0) CALL INTI					and the same statement of the same and		
		IF (IX.NE.O) STOP INPU	T ETIC ATTACH NO	II CATTOCA	CT00V4				
65	CDID.	WRITE(7,120) (DATIN(I	1, I=1,2)	•	Clukip		<u></u>		
) 	120	FORMAT(23H THIS READS	INPUT FILE , 2A1	.0/)					
	122	CONTINUE	TOLUCCEO PENODE	<u>-</u>		• •		• •	
	-1,000	RANSFER STATEMENT 'CALL INTIO(6HNSTART,N	IKANSPEK IGNUKEL) 	- 45 4.				
		NSTOP=NSTART							
70		CALL INTIO(6H NSTOP, N		•	•	*** *	270.2	•	•
		CALL LOGIO (6HTETHRD, T							
		IF(IRCVR.EQ.1) GO TO CALL LOGIO(6HADAPTV,A							
	125	CONTINUE	P	,	- 37 - 87 - 1			•• • • • • • • • • • • • • • • • • • • •	
75		IF(TETHED) ITETHE=2							
• • • • • • • •	• •	IF (ADAPTV) GO TO 135		×			•	•	
		IRSIGN=-1				_			
	135	IADAP=3 CONTINUE		- / /	•				
. 80	-*	DO 145 I+2,6							
	_	IASC=3*(I-1)+IDNRS(I)							
,	7/5	IDENTS(I)=IDASCI(IASC	}				,		
	145	CONTINUE	11 TD4CCT/TCYN1.	THOS				• •	
85	150	ENCODE(8,150, IDENTS(1 FORMAT(A7,11)	11 IDM3C1(1310))	TUUU				•	
	-	WRITE (7,152) IDNRS, I	HOD ' ' "			"" \."			
	152	FORMAT (1H ,611,1X,11	/)						
-		WRITE (7,153) IDENTS	* * * ****			* .			
90	153 155 "	FORMAT (1H , A8) CONTINUE	١			!			
,,	200	READ(10,160) NRUN, DSN	RDB.RHO.BETA.ESC	.BMLS.BRC	VP				
• • •	160 **	FORMAT(15,6G10.3)		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	*15				
		IF(NRUN.LT.NSTART) GO							
- ·		IF(NRUN.GE.NSTOP) MOR	E=.FALSE.		. `				
95	٠ ي	RETURN						_	
	C****	********	*****	****	****	****	, ,		
	Č	· · · · · · · · · · · · · · · · · · ·	* * **********************************	· · · · · · · · · · · · · · · · · · ·		**************************************	p		
	200	CONTINUE					1		
100	C THIS	S DUTPUTS BASIC SIMULA	TION DATA OF INT	TEREST, SU	CH AS				
	CTHE /	ANGLE FUNCTION, INITIA	L STATE, ETC.						
	21.0	WRITE(7,210) NRUN,DSN	RDB,RHO,BETA,FSC	BHLSBRC	VR				•
	210	FORMAT(5H1NRUN,12X,6H 44HBHLS,15X,5HBRCVR/1H	03NKUBJ10XJ3HKHL 0.14.4/10Y.C10.5	1, 10X, 4HBE	TA) TYX, 3HFS	C+16X+			
105	,	IF(NRUN.LE.9) ENCODE(10.220.DDHT) TO	IRS.1HU.TH	DO. THO. NRUN				
 .	220	FORMAT(611, A1, 11, A1, I			,				
		IF (NRUN.GE.10) ENCODE		NRS, 1HU, I	HOD, NRUN				
	230	FORMAT(611, A1, 11, 12)				-	•		
110	****	IX=IREQST(6LTAPE17,3L		••					
***		IF(IX.NE.O) CALL INTI IF(IX.NE.O) STOP#OUTP			EACTORVA	. ,	•		
		Tourness Sinksholk	~: !*FF VCAAC3	MUI DAILD	INCLURIF				
• •		WRITE(7,240) (DATHUTE	I), I=1,21						
• •	240	WRITE(7,240) (DATOUT(FORMAT(25HOTHIS WRITE		2A10)					

208800114	E CONTRL 73/172 TS . "" FTN 4.6+452 ' ' 05/18/79 13.43.46 PAGE
115	CALL DATE(TODAY) . WRITE (7,250) FUNCTN (IAE), IAE 250 FORMAT (1H0,A7,15H FUNCTION (IAE=,II,IH)) WRITE (7,260) ((I,X(I)),I=1,8)
	260 FORHAT (15H0INITIAL STATE://(3H X(,11,4H) = ,G13.61)
120	WRITE(7,270) FDENTS(2) 270
-	C
125	-300 - CONTINUE
	C THIS IDENTIFIES THE BASIC RECEIVER STRUCTURE (THRHLD, OPT, SUBOPT) CAND REINITIALIZES, AS NECESSARY, THE FOLLOWING RCVR DATA CIR (NEGATE ONLY), NOAC, NOKLHN, NOLOE, BRCVR, DELBL, TETHRD ITIT=HINO(IRCVR, 2)
130	· ·
	C NEGATE IR WITH THE FOLLOWING FOR NONADAPTIVE RECEIVER IF (IRSIGN-LT.0) IR=-IR
135	RETURN
*32	C+++++++++++++++++++++++++++++++++++++
140	C 400 CONTINUE C THIS OUTPUTS BASIC RECEIVER DATA OF INTEREST WRITE(7,410) (IDENTS(I),I=3,4),IR,NG,NS -410 FORMAT (1H0,AB,4HRCVR/1H0,AB,6HDESIGN/5H (IR=,I2,4H,NG=,I1,4H), 44.NS=,I1,1H)

145	RETURN
# 4 	· C++***********************************
150	C THIS SETS-UP THE MSET-LOOP
	C THIS SETS-UP THE MSET-LOOP RETURN
	TO A TO THE TO THE TO THE TOTAL THE
155	C + + + + + + + + + + + + + + + + + + +
	C THIS SETS-UP-THE LG-LOOP FOR THE (MSET)-TH-SERIES OF SETS
160	C + + + + + + + + + + + + + + + + + + +
	700 CONTINUE
165	-C THIS SETS-UP THE K-LOOP FOR THE (LG)-TH SET OF KM SCANS CALL INTIO(6H KM,KM,1,1) WRITE(7,710)-(TITLE1(1),1=1,3),(TITLE2(1,1TIT),1=1,2) 710 FORMAT (4H0 K,6X,5HCSNRT,6X,5HCSNRF,5(5X,A6,4X)/)
	EHEAN=0;
170	EHS=0. LASTCT=0

JOBRAGII IN	CONTRE	13/112 13		FIN 4407472	02/18//4	13.43.40	PAGE	4
								•
	C	•						
	C*****	*********	**********	************	* *		• •	
	Ç	•			•			
175	800 CON	TINUE	, ,			•		
175	C THIS IN	ITIALIZES THE K-TH SCAN						
		=SPACE						
,	REI	URN						
	C*******	********						
` 180	C	*******	****	*********	• ,		•	
	T	TINUE						
		VES/PREPROCESSES DATA FRO	M THE K-TH SCAN					
	IF(ICOUNT.NE.LASTCT) SEP-ABO	RT					
		RR=X(2)-XS(2)	•	•				
185		8 THERR						
• • • • • • • • • • • • • • • • • • • •	TT DTH	E=X(2)-X(5)		•				
	IF	(IRCVR .NE. 1) COL8=SQRT(PPDIAG(2))					
, , , , , , , , , , , , , , , , , , , ,	IF.	(IRCVR .EQ. 1) CALL DELTR	1(COL8, THERR, FL1	0)			• • •	
	41/1	・1 こいしょうかかり ひしゅつかんしょぐうがんしゅい	. しとしまい BEまえる (としまる	ヒアタ(HEKKタしひしひ				
190	910 FOR	MAT (1H >13,2(2X,69.3),3(2X,G13.6),1X,A1,	1X,G13.6,2X,G13.6)				
		RTD(K)=CSNRT						
	*****	RFR(K) • CSNRF · · · · · · · · · · · · · · · · · · ·				-		
		SEP(K)*DTHE SER(K)*THERR "" "						
195 1		ORT(K)=SEP	•				,	
		TCT=ICOUNT		- ,				
	rue	** U = F U F + U + T U F B B	•					
	EMS	=EMS+THERR**2		HT P 7 4		t	•	
_		URN				ح		
200	C		M 444 - W F1-W- 444- 2	***				•
	C******	******	*******	********	*			
	C , , ,		- , , , , , , , , , , , , , , , , , , ,	••			•	;
	1000 CON						•	
205	C IHIS SA	VES/PROCESSES/OUTPUTS DAT	A'FROM'THE (LG)-	TH SET OF KH SCANS		(2 .2		
		AN=EMEAN/KH =EMS/KM" """""""""""""""""""""""""""""""""""		· ·			- 1v	
		S*SQRT(EMS)						
		DEV+SQRT(EMS-EMEAN++2)	*** *** * **					
		ICBUNT						
210		UNT=100.*XW/KH ' ' ' ' '						
		(TE(7,1010)						
	1010 FDF	RMAT (31HOTHETA-ERROR SAME	LE'STATISTICS:) "		.,	** *** ***		•
		(IRCVR .EQ. 1) WRITE(7,10						*
		RMAT (17H (FILTERED ERROR)		• • • • •	-			
215	WR 3	TE(7,1030) ENEAN, ERMS, EST	DEV					
, , ,	1030 FO	RHAT (10HO EMEAN = .G13.6/	'10H ERMS - , G1	3.6/			•	•
	**************************************	ESTDEV = , G13.6)						
	1040 500	(IRCVR 1 EQ. 1) WRITE (7,10	140) ICUUNI			•	•	
220		RMAT (//1H0,F7,2,22H% OF S [N=YMAX=0,************************************	CANS ARE ABORTED	3				
		TE (7,11)		•		,		
		L PLOTR (THESEP, THESER, KM,	YNAME.YNAME.YMTN	* YM A X * O)			•	
	WR	(TE (7,11)	MINING FINANCE FILLS	,				
		L REALID(6H" YHIN, YHIN, 1)		n new 1964 firm on two to \$1.5		784- t > 44 - 4	•	
225	CAL	L REALIO(6H YMAX,YMAX,1)						
	- '- IF	(IRCVRNE. 1) WRITE(7,10	60) (GQGT(I,I),I	=1,NS)	•	•		
	1060 FDF	RMAT (10(/),35H ON LAST SC	AN, DIAGONAL OF	GOGT WAS/				
						• •		

" SUBROUT	THE CONTRL" 73/172 TS FTN 4.6+452 " 05/18/79 13.43.46 PAGE
	*1H
230	H13414317447
~	WRITE(7,1070) (DATOUT(I), I=1,2) 1070 FORMAT(13H OUTPUT FILE ,2A10,1H:/)
	TOTO FURNALLED DUTE TO FILE FEATURE (CHAY VM TODAY IRDAK
	WRITE(7,1072) DOUT; DELT, MTIMES, LGMAX, KM, TODAY, JBNAM 1072 FORMAT(1H , A10, 8X, G13.6,5X, 3(5X,13,10X), A10, 8X, A10/)
	WRITE(7.1074) IDENTS
235	
	WRITE(7,1076) NRUN, DSNRDB, RHO, BETA, FSC, BHLS, BRCVR 1076 FORHAT(1H ,5X,12,6X,6(5X,G13.6)/) TKH#HINO(35.KH=91
	1076 FORMAT(1H ,5%,12,6%,6(5%,G13.6)/)
	IKH=HINO(35,KH-9)
	DO 1977 I=1, IKR
240	1077 WRITE(7,1078) CSNRTO(I),CSNRFR(I),THESER(I),ABBORT(I),THESEP(I),I
	1078 - FORHAT(1H ,3(G13.6,5X),6X,A1,11X,G13.6,5X,17)
	00 1079 I=1,5
	TALL MUTICALITATION
	1080 FORMAT(1H,6(6X,1H,,11X))
245	
	DO 1081 I=KH3,KH
	1081 - WRITE (7, 1078) CSNRTO(I), CSNRFR(I), THESER(I), ABBORT(I), THESEP(I), I
	WRITE(7,1082) EMEAN, ERMS, ESTDEV, TCOUNT, YMIN, YMAX
250	
200	WRITE(17) DOUT, DELT, MTIMES, LGMAX, KM, TODAY, JBNAM WRITE(17) IDENTS
	HATICITY DOUNG DENOAD DUM ACTA CCC AND CARROOT
	WRITE 17) NRUN, DSNRDB, RHO, BETA, FSC, BHLS, BRCVR DO 1090 I=1, KH
•	
255	WRITE(17) CSNRTO(I),CSNRFR(I),THESER(I),ABBORT(I),THESEP(I),I
	WRITE(17) EMEAN. ERMS, ESTDEV. TCDUNT. YMIN. YMAX
	REWIND 17
	IX=IATTACH(6LTAPE20,DATDUT)
	- CALL RETURN(6LTAPE20)
260	IF(IX.NE.O) GD TD 1095
	TX-ICATALO(6LTAPE17,DATOUT,2LPW,8RHIGHFILL,2LRP,365)
	GO TO 1096
	1095 TIX=ICATALO(6LTAPE17, DATOUT, 2LXR, 8RHIGHFILL, 2LRP, 365)
	1096 IF(IX-NE-0) CALL INTID(6HIX(CA),IX,1,1)
265 -,-,	
	CALL RETURN(6LTAPE17)
	1000 GORNATICALIONATUTE (7,1099) (DATOUT(I), I=1,2)
	1099 FORMAT(13HOOUTPUT FILE , 2A10, 33H IS WRITTEN, CATALOGED AND CLOSED)
270	KEIUKR
	··· C++++++++++++++++++++++++++++++++++
•	r '
,	1100 "CONTINUE"
	C THIS SAVES/PROCESSES/OUTPUTS DATA FROM THE (MSET)-TH SERIES OF
275	CLGHAX SETS OF KM-SCANS
	RETURN
	C ************************************
	1200 CONTINUE
280	
	C'THIS EFFECTS CLOSURE OF THE SIMULATION RUN
	RETURN
þ	C + + + + + + + + + + + + + + + + + + +
<u>කු </u>	- A
<u></u>	
14	,
A 4.5°	·

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430008 CH STBRAGE USED 4.098 SECONDS

DATA_TITLE1/6H_ALFA_6H_THETA_6HTHEDOT_6H_ALFAR_6HTHETAR_6HTHRDOT_______

*/.FALSE./,FILOUT/.TRUE./

C,6H B ,6H WSC ,6HWSCOOT/
DATA XNAHE/8H BETA ,8HDEGREES /,YNAME/8HTHES ERR;8HDEGREES /
DATA XNAHE/8H BRATID ,8H /
DATA FUNCTN/7HAZIMUTH,7HELEVAT.

SUBROUTINE	CONTRL	73/172	OPT=0 TRACE	.	FTN 4.6+452	04/13/79 10.20.09	PAGE	2
	c .		* ****			******* * * ** *** * * * * * * * * * *	1 / 24 44 1	
•	GO TO	(100,20	3,300,400,500,60	0,700,800,900,1	000,1100,1200),IS	w		
60	1 FORMA	T(1H)	· · · · · · · · · · · · · · · · · · ·					
	TO LOUIS	117171				•		
	.11 FORMA	T (1H1)_	- ** * ** -*		~ · · · · · · · · · · · · · · · · · · ·			_
		******				***		
65	C	*******		**********	*****	**************************************	-	
	100 CONTI	NUE						
	C THIS IDEN	TIFIES T	HE SCENARIO AND	REINITIALIZES,	AS NECESSARY,	Mar architect of representation of the states as the A	•	
	CTHE FOLLOW	ING RECE	IVER PARAMETERS .					
~~							• • • •	
. 10	17 (NF	1851) 60 •TRUE•	TO 155			** * *** , , ,		
		T - TRUE						
		-JOBNAME	(1)					
	ISIH-							
75``""	1 MOD :	ī · ~ ~ ~						
*** ** * * * *	WRITE	(7,110)						
	110 FORMA	T(38H1RM	SE VS.BRATIO = B	RCVR/BHLS SCENA	RIO/) " '	• • • •		
	. CALL	LUGIU(6H	FILLIN, FILEIN, O)					
80	41. 14	MAISTER	(N) NSTART=0 N) GD TO 122					
	IX=IA	TTACHIAL	TAPE15, DATIN)		·	· · · · · · · · · · · · · · · · · · ·		
	1F(1)	.NE.01 C.	ALL INTID(6HIX(A	T) • IX•1•1)				
	16(1)	-NE-DIS	INDUTNOIS CYIC A	TTACU NOT CATTE	E & C T O D V 4			
	WRITE	(7,120)	(DATIN(I), I=1,2)					
	120 FORMA	T(23H TH	IS READS INPUT F	ILE ,2A10/)	- 4 (4) 11 2 1111		•	
	"TSS""" CYLL"	LUGIU(6H	FILOUT, FILOUT, 0)	^ ^ ·		***************************************		
	NSTRE	=NSTART	FILOUT, FILOUT, 0) START, NSTART, 10	0.01				
· ·	" CALL	HAIDITAL	NSTOP.NSTOP.100	٠				
90	CALL	FOCIO (PH.	TETHRO, TETHRO, 0)	, , ,		•		
	CALL	FOCIO (PH	KO KYZAKOK KVTAKOM					
	TED CONIT	NUE				- 1	1	
95	IF(AD	THRD) IT	TO 135 '		, ,			
••	IRSIG	N=-1	10 737	~~~~~~				
	IADAP			~ · ·				
	_135 CONTI	** *				23 🚛		
100	00 14	5 I=2,6					,	
100	IASC*	3*{1-1}+	DNRS (1)+2					
	145 CONT	2 (T)-INV	SCI(IASC)			77		
			DENTS(1)) IDASC	1/15TM1.1M00		· 44 35		
	150 FORMA	T(A7,11)		* 1232117721100		· · · · · · · · · · · · · · · · · · ·		
105			IDNRS, I HOD				**	
			(1,1X,II/)					
_	WRITE	(7,153)	IDENTS					
	153 FORMA	T (1H ,A	LGMAX, LGMAX, 13,		• •			
110	CALL	INTID(6H	LUMAX,LUMAX,13,	0)				
. - • ∨	CALL.	REALIGION	KH,KH,115,0) HBRARAT,BRARAT,O				. 4	
	KSTAR	T=HINO (K	MAKSTART)	•				
•		0(1)=1.						
	BRATE	IX=SQRŢ(B	RARATI					

ROOT = 1 . / (LGHAX-1) IF(LGMAX.LE.1) GO TO 156 DD 154 I=1.LGMAX

115

```
BRATIO(I)=BRATMX++(2.+RODT+(I-1)-1.)
                KMNET=KM-KSTART+1
120
                FSCHIN=1./(DELTAT(IAE)*KMNET)
                NRUN=NSTART-1
                DSNRDB=20.
                RH0=0.5
                BETA=45.
125
                IFS=1
                TSEP=1.
                CONTINUE
                 IF(FILEIN) GOTO 158
                NRUN=NRUN+1
130
                WRITE(7,11)
                CALL INTID(6H NRUN, NRUN, 1, 1)
                CALL REALIG(6HOSNRDB, DSNRDB, 0)
                CALL REALID(6H RHO, RHO, O)
CALL REALID(6H BETA, BETA, O)
135
                 CALL INTIG(6H IFS, IFS, 100,0)
                CALL REALID(6H, TSEP, TSEP, O)
                GDTO 167
           158 CONTINUE
                READ (15,160) NRUN, DSNROB, RHO, BETA, IFS, TSEP
140
                IF(EDF(15))170,165
FORMAT(15,3G10.3,5X,15,2G10.3)
           160
         FSC=IFS*FSCMIN
145
                 XO(5, IAE) = XO(2, IAE) -TSEP
                XO(3, IAE) +0.
                 XO(6, IAE) = 0.
                 RETURN
           170 STOP #EOF REACHED ON INPUT FILE#
150
           C THIS OUTPUTS BASIC SIMULATION DATA OF INTEREST, SUCH AS....
           CTHE ANGLE FUNCTION, INITIAL STATE, ETC.
WRITE(7,210) NRUN, DSNRDB, RHO, BETA, IFS, TSEP
           210 FORMAT (5HONRUN, 12X, 6HDS NRDB, 16X, 3HRHO, 16X, 4HBETA, 16X, 4HIFSC, 16X,
               *4HTSEP/1H0,14,3(10X,G10.3),12X,15,3X,_____
                *(10X,G10.3))
160
            IF(.NOT.FILOUT) GOTO 245
                IF (NRUN.LE.9) ENCODE (10, 220, DOUT) IDNRS, IHU, IHOD, 1HO, NRUN
           220 FORMAT(611, A1, 11, A1, 11)
                 IF (NRUN.GE.10) ENCODE(10,230,DOUT) IDARS, 1HU, IMOD, NRUN
           230 FORMAT(011, A1, 11, 12)
IX=IR EQST(6LTAPE17, 3L*PF)
165
                IX=IREQST(6LTAPE17,3L#PF)
IF(IX.NE.O) CALL INTIQ(6HIX(RQ),IX,1,1)
IF(IX.NE.O) STOP#OUTPUT FILE REQUEST NOT SATISFACTORY#
           WRITE(7,240) (DATOUT(1),1=1,2)
240 FORMAT(25HOTHIS WRITES DUTPUT FILE ;2A10)
170
```

245 CALL DATE (TODAY)

_		_	
			WRITE (7,250) FUNCTH (IAE), IAE 250 FORMAT (1H0, A7, 15H FUNCTION (IAE=, II, 1H))
	175		WRITE (7,260) ((1,X(1)),I=1,8) 260 FORMAT (15HOINITIAL STATE://(3H X(,II,4H) = ,GI3.6)) WRITE(7,270) IDENTS(2)
			270 FORMAT(1H0,A7) RETURN
	160	•	C C***********************************
-	. <u>.</u> .		300 CONTINUE C THIS IDENTIFIES THE BASIC RECEIVER STRUCTURE (THRHLD, DPT, SUBOPT)
	185		CAND REINITIALIZES, AS NECESSARY, THE FOLLOWING RCVR DATA CIR (NEGATE ONLY), NOAC, NOKLMN, NOLOE, BRCVR, DELBL, TETHRO ITIT=HINO(IRCVR, 2)
			C NEGATE IR WITH THE FOLLOWING FOR NONADAPTIVE RECEIVER
	190		IR=ISIGN(IR, IRSIGN) C RETURN
			C C + + + + + + + + + + + + + + + + + +
	195		400 CONTINUE C THIS DUTPUTS BASIC RECEIVER DATA OF INTEREST WRITE(7,410) (IDENTS(I),I=3,4),IR,NG,NS
	•	•	410 FORMAT (1H0,A8,4HRCVR/1H0,A8,6HDESIGN/5H (1R=,12,4H,NG=,11, " + 4H,NS=,11,1H))
	200		WRITE(7,420) (IDENTS(1),1=5,6) 420 FORMAT(1HO,A8/1HO,A7/) RETURN
			C C***********************************
	205		C THIS SETS-UP THE MSET-LOOP
-	•	, ,	ICOUNT=0 DD 510 I=1,LGMAX
	210		YYMI(I)=1.E322 510 YYMA(I)=-1.E322 RETURN
-			. C
	215		C 600 CONTINUE - C THIS SETS-UP THE LG-LOOP FOR THE (MSET)-TH SERIES OF SETS
		, .	RETURN
	220	-	C*************************************
			C THIS SETS-UP THE K-LOOP FOR THE (LG)-TH SET OF KM SCANS BMLS-AHAX1(1.,1./BRATIO(LG))
	225		BBB=2.4/BMLS BRCVR=AMAX1(BRATIO(LG),1.) BB=2.4/BRCVR
			PDCRIT=PI*BB/8. CC=PI*PDCRIT
		-	17 OF STATE A SERVICE OF THE SERVICE

	SUBROUTINE	CONTR	IL 73/17	2 OPT = 0 TP	RACE		. , , ,	FTN 4.6+452	04/13/79	10.20.09	PAGE
			x(7)=x0(7,1								
230)		DUM=GAUSS(1								
			WRITE(7,11) CALL INTIO(100 - 1 - 1	1.5		•			,
			WRITE (7, 705								
		705			9 C X C و 2	BRATIO =	,G12.5/8F	+ BHLS = ,G12.	5,5X,		
235			8HBRCVR .			-	•	•			
			WRITE(7,710			124					
		710	FORMAT (6HO	K • 4X • 5HC	SHRT	X > SHOTY	,9(3X,A6,	2X))			
		4.	DD 712 I 1,	NS							
240	}	712	EMEAN(I) TO.			•					•
			EMS(I)=0. LASTCT=0			1- ***	•				
			ICOUNT=0								
			00 730 IPA-	1,NS							,
. 245	· · · ·		DO 720 JPA * PA(IPA, JPA)	1, NS							•
			CONTINUE							Ŧ	
			CONTINUE			£.					
250	,	c	RETURN		_						•
290	,	C****	******	******	****	****	*****	*****			
		C				72 7 . 23 2	* : * : 5 * * * * *		• •		
			CONTINUE			-		•			
255			INITIALIZE Sep≠Space	5 1HE K-1H	SCAN				,		
	•		RETURN	**			•				
		C _		**							
		C****	******	*******	****	*****	******	****	***	- •	•
260		-	CONTINUE				•	•		-	,
			SAVES/PREP	ROCESSES DA	TA FRO	M THE K-T	H SCAN			,	
			IF (ICOUNT.N	E.LASTCT) S	EP=ABO	RT	•				
			DO 905 I=1, ES(I)=X(I)-1			· · · · · · · · · · · · · · · · · · ·			*** * * *** * ** ** **		
265	,		IF(NS.GE.7)		X (7))-	ABS(XS(7))				
	·		IF (NS.GE.8)		X(8))-	ABS(XS(B))		•	, -	
			BETTA=(180. COL8=THERR	/PI)*X(7)		- 44		•		•	
			IF (IRCVR .	NE. 1) COL8	-SORT (PPDIAG(2))	•			
270		-	IF (IRCVR .	EQ. 1) CALL	DFĹTR	1(COL8,TH	ERR, FL10)	• • • • • • • • • • • • • • • • • • •	m		
			IF((NRUN.EQ	• NSTAKT • AND	LG.EQ	.1).UR.(K	•EQ•KMJ)	GOTO 906 _			
			WRITE(7,910	K.CSNRT. (X (T) • T	=1.NS)					
	•	910	FORMAT(3HO	,13,2X,G10	.3,5H	X= ,2X,9	(G10.3,1X	3)	•		
275			WRITE(7,920								
			FORMAT(18X)! WRITE(7,930								
	-	930	FORHAT(18X)	5H ES+ ,2X,	9(610.	3,1X))"" ~		- • • •	•		
			TEITORNO CA	4.6 11077879	0/01	2010					
280		9.40 9.50	FORMAT(8X,1 XDATUM(K)=B	PHUNFILT. E	2(2)=	,13X,G10.	3)	,	•		
			THESER (K)=TI	IERR							•
	, .		LASTCT≟ICOU	NT,							
285			IF{K.LT.KST. DO 960 I=1,1						-· ·	ah t	
2.02		•	ng 200 'T-ÝÌ	19 ,,	1				pierre A 44s	-	

		to the company of the
		EMEAN(I) = EMEAN(I)+ES(I)
	960	EMS(I)=EMS(I)+ES(I)++2
		RETURN
	C	
., 290	C+++*	*************
	1000	CONTINUE
		S SAVES/PROCESSES/OUTPUTS DATA FROM THE (LG)-TH SET OF KM SCANS
* A U		DO 1005 I=1,NS
295		EHEAN(I) = EHEAN(I)/KMNET
		EHS(I)=EHS(I)/KHNET
		ERMS(I) +SQRT(EMS(I)) ESD(I) +SQRT(EMS(I)-EMEAN(I)**2)
	1005	CONTINUE
.300		XW=ICOUNT
		TCOUNT=100.+XW/KH
		WRITE(7,1009)
	1009	FORMAT(3(/)) WRITE(7,1010)KMNET
305	1010	FORMAT(5X,26HERROR SAMPLE STATISTICS: (,13,9H SAMPLES))
		IF(IRCVR.EQ.1) WRITE (7,1015)
	1015	FORMAT(5X,31HTHRESHOLD RCVR (FILTERED ERROR))
		WRITE(7,1020)(TITLE1(I), I=1,NS)
310	1020	
J	1030	WRITE(7,1030)(EMEAN(I),I=1,NS) FORMAT(1H0,16X,8HEMEAN = ,9(G10,3,1X))
	2450	WRITE(7,1040)(ERMS(I), I=1, NS)
****	1040	FORMAT(18x, 7HERMS = ,9(G10.3,1x))
		WRITE(7,1050)(ESD(I),I=1,NS)
315	1050	FORMAT(19X, 6HESD = ,9(G10.3,1X))
	1060	IF(IRCVR.EQ.1)WRITE(7,1060)TCDUNT FORMAT(//1H ,4%,F7.2,22H% DF SCANS ARE ABORTED)
	2000	IF(IRCVR.NE.1)WRITE(7,1070)(GQGT(I,I),I=1,HS)
	1070	FORMAT(5(/),4X,35H ON LAST SCAN, DIAGONAL OF GOGT WAS/26X
. 320		C9(G10.3,1X)}
		00 1071 I=1,NS
		EEMEA(LG,I)=EMEAN(I) EERMS(LG,I)=ERMS(I)
	1071	EESTD(LG, I) = ESD(I)
325		DO 1072 I=1,KM
	30301	YYHI(LG)=AMINI(THESER(I),YYHI(LG))
	1072	YYHA(LG)*AMAX1(THESER(I),YYMA(LG)) TTCO(LG)*TCOUNT
· ·		IF (LG.NE.1) RETURN
5 _. 330		YHIN=YHAX=0.
-24		WRITE(7,11)
		CALL INTIO(6H NRUN, NRUN, 1, 1)
		CALL PLOTR(XDATUH, THESER, KM, XNAME, YNAME, YHIN, YHAX, O) RETURN
335	С	RETURN
-	C****	**********
•	C	to the same was a same as a sa
		CONTINUE
340	CITHI	S SAVES/PROCESSES/OUTPUTS DATA FROM THE (MSET)-TH SERIES OF X SETS OF KM SCANS
J 7 U	CLUNA	WRITE(7,11)
		CALL INTIO(6H NRUN,NRUN,1,1)
		The same of the sa

		1 (1818 to 191 A 1 willing Williams to both a bir to be a sound out
		WRITE(7,1110) 6HBRATIO, (TITLE1(1), I=1, NS)
• • •	1110	
345		WRITE(7,1120)BRATIO(1); (EEHEA(1,1); I=1,NS)
,	1120	FORMAT(1HO, 7X,7HEMEAN: ,9(G10.3,1X))
		DO 1130 J=2, LGMAX
	1130	WRITE(7,1161)BRATIO(J), (EEMEA(J,I),I=1,NS)
		WRITE(7,1140 BRATIO(1), (EERHS(1,1),1=1,NS)
350	1140	FORMAT(1HO, 8X,6HERMS; ,9(G10.3,1X))
•	•	DO 1150 J=2,LGMAX
	1150	
		WRITE(7,1160)BRATIO(1),(EESTD(1,1),1-1,NS)
	1160	
355 .		DO 1165 J=2,LGHAX
	1165	WRITE(7,1161)BRATIO(J), (EESTD(J,I),I=1,NS)
	1161	
		IF (.NOT.FILOUT) GOTO 1199
360	- -	WRITE(7,11) WRITE(7,1170) (DATOUT(I), I=1,2)
300	1170	
-	1110	WRITE(7,1172) DOUT, DELT, MTIMES, LGMAX, KM, TDDAY, JBNAM
	1172	
r r france		WRITE(7,1174) IDENTS, KSTART
365	1174	FORHAT(1H ,6(1X,A8,9X),6X,13/)
* "" "" "" " " " " " " " " " " " " " "		WRITE(7,1176) NRUN, DSNROB, RHO, BETA, FSC, TSEP
	1176	
		DO 1175 LGN=1, LGMAX
	1175	WRITE(7,1182) EEME(LGN), EERM(LGN), EEST(LGN), TTCD(LGN), YYMI(LGN),
370	,	*YYHA(LGN),BRATIO(LGN),LGN
	1182_	FORMAT(1H ,7(G13.6,5X), I5)
- , .,		WRITE(17) DOUT, DELT, MTIMES, LGHAX, KN, TODAY, JBNAH
		WRITE(17) IDENTS, KSTART
		WRITE(17)NRUN, DSNROB, RHO, BETA, FSC, TSEP
375		DD 1190 LGN=1,LGMAX
	1190	
		*YYMA(LGN), BRATIO(LGN), LGN
		IX=IATTACH(6LTAPE20,DATGUT)
380		IF(IX.NE.O) GO TO 1195 READ(20) DUH,DUH,IDUH,IDUH,JDUH,JDUH
500		CALL RETURN(6LTAPE20)
•		REVIND 17
		IX=ICATALO(6LTAPE17,DATOUT,2LPW,8RHIGHFILL,2LRP,365)
	- •-	60 TO 1196
385	1195	
•		REWIND 17
		IX-ICATALO(6LTAPE17,DATOUT,2LXR,8RHIGHFILL,2LRP,365)
	1196	
		IF(IX.NE.O) STOP#OUTPUT FILE CATALOG NOT SATISFACTORY#
390		CALL RETURN(6LTAPE17)
_ ,		WRITE (7,1198) (DATOUT(I), I=1,2)
	1198	FORMAT(13HOOUTPUT FILE >2A10,33H IS WRITTEN, CATALOGED AND CLOSED)
	ļ199	
206		DO 1103 I=1,NS
395		FACTOR*1. IF(I.EQ.7) FACTOR*180./PI
		IF(I.EQ.B) FACTOR=.5/PI
		IF(I.EQ.9) FACTOR=.5/PI
		YHIN=0.
		The state of the s

```
400
               YHAX=0.
DD 1101 LG1=1,LGMAX
           1101 EEHE(LG1) = EERHS(LG1, I) * FACTOR
                YNAMEL(1)=YNAM1(1,1)
                YNAME1(2)=YNAM1(2,1)
405
               K1=M00(I,2)
                IF(K1.Eq.1) WRITE(7,11)
                IF(K1.EQ.1) CALL INTIO(6H NRUN, NRUN, 1, 1)
                  IF(K1.EQ.0) WRITE(7,10)
                CALL PLOTE (BEATIO, EEME, LGMAX, XNAME1, YNAME1, YMIN, YMAX, O)
           1103 CONTINUE
...410
               RETURN
           C
           415
        1200 CONTINUE ... C THIS EFFECTS CLOSURE OF THE SIMULATION RUN ...
                RETURN .
           420
```

END

PAGE

	and the state of t
	SUBROUTINE CONTRL(ISW)
	C THIS CONDUCTS THE HLS SIMULATION THROUGH A
5	C RMSE VS. FSC STUDY
	REAL LAMDA
	INTEGER XNAME1(2), YNAME1(2), YNAM1(2,9) INTEGER XNAME(2), YNAME(2), DATIN(4), DATOUT(4), DOUT
	INTEGER XNAME(2), YNAME(2), DATIN(4), DATOUT(4), DOUT
10	INTEGER TITLE1(9), FUNCTN(2) LOGICAL NOKLKN, NOLDE, NOAC, KALHAN, LOE, TETHRO, HORE, NFIRST, ADAPTY,
	CFILEIN.FILOUT
	COMMON/IDDATA/ISIM,IPMLS,IRCVR,IADAP,ITETHR,IPOPT COMMON/RCVROO/THAMAX.THAMIN,TS,TR,OHEGA,TF
	COMMON/RCVROO/THAMAX, THAMIN, TS, TR, OHEGA, TF
15	COMMONYKCYKOZYNGMINANGMAXADELBLANGMAIKAIAE
1,5	COMMON/RCVRO2/RHOMAX, DTHO, TDRO, BO, WSCO, NSO(4), NGO(4) COMMON/RCVRO3/PI,F(8,8),FL25(4),FSAHP,K,KM,TETHRO,NG,NS,JM
	COMMON/RCYRO4/DELT.ED(B). 2007(18,83.H/5.R).TCOINT.STGMA
	COMMON/RCVRO5/NOLDE, NOKLMN, NOAC, GAMAES (5), RDIAG(5), PHDIAG(8)
	COMMON/RCVRO4/PIFF(8,8),FL25(4),FSAMP,K,M,TETHRD,NG,NS,JM COMMON/RCVRO4/DELT,EO(8),GOGT(8,8),H(5,8),ICOUNT,SIGMA COMMON/RCVRO5/NOLDE,NOKLMN,NOAC,GAMAES(5),RDIAG(5),PHDIAG(8) COMMON/RCVRO6/PPDIAG(8),RMAT(5,5),PHI(5,5),PA(8,8),LAMDA(5)
20	COMMON/RCVR07/T(130), V(130)
	COMMON/RCVRO8/XSLOE(8), ESLOE(8), ES(8)
	COMMON/RCYRIO/XXI(8).XX(8)
	COMMON/RCVRO9/BRCVR,BB,PDCRIT,CC COMMON/RCVRIO/XS1(8),XS(8) COMMON/MLSOOO/ALFA,THE,THEOOT,ALFAR,THR,THRDOT,B,WSC
25	ACHICIA II E SAATA CSUK I S CSUK LED SUKUBE KUDE E KAE E CEL CAUX
	LUMBUN/BLSUOZ/DCSNR.CSNR.LG.TPKT.TPKE
	COMMON/MLSOO3/FL10AE(4,2),FL10(4),DELTAT(2),XD(8,2),YU(4,2). COMMON/MLSOO4/8HLS,888,MTIMES,MSET,MORE
	DIMENSION X(8), THESER(115), XDATUM(115), FEME(13), FERM(33)
30	DIMENSION IDNRS(6).IDASCI(20).IDENTS(A).EEST(12).TTCD(12).VVHY(12)
	DIMENSION YYMA(13)
	DIMENSION FSCA(13), IFSCA(13) DIMENSION EEMEA(13,9), EERMS(13,9), EESTD(13,9).
•	ATHENSION ENGANGATIONS (ATTENSION ATTENSION AT
35	EQUIVALENCE (EEHE(1), EEHEA(1,2)), (EERH(1), EERHS(1,2)),
	*(EE31(1),EE310(1,2))
	EQUIVALENCE(THERR, ES(2))
	EQUIVALENCE (ALFA)X(1)),(ISIM,IDNRS(1)),(DOUT,DATOUT(2)) DATA YNAM1/8HALF RMSE,8H ,8HTHE RMSE,8HDEGREES ,
40	*8HTDT RMSE/SHOEG/SEC *BHALR RMSE/SH - SHITHD DMSE.
	*8HTDT RMSE, 8HDEG/SEC , 8HALR RMSE, 8H , 8HTHR RMSE, 8HDEGREES , 8HTHR RMSE, 8HDEGREES , 8HDEG/SEC , 8HBET RMSE, 8HDEGREES ,
	ADULDO MUDENOU UZ NOULOCHKUZENSH HZVZEC N
	. DATA ABORT/1HA/, SPACE/1H /, NFIRST/.FALSE./, ADAPTV/.TRUE./
45	DATA DATIN/10HMLSSIMDATA,10H200000F000,2*0/
	DATA DATOUT/10HMLSSIMDATA;3+0/ DATA DATOUT/10HMLSSIMDATA;3+0/ DATA IDASCI/7HCROSSMP,7HRMSE(T),7HRMSE(B),7HRMSE(F),7H *8H PMLS1 ,8H PMLS2 ,
	*8H PMLS1 ,8H PMLS2 ,
	*6H PMLS3
50	*8HNONADAP ,8HUNTETHRD,8HTETHERED,2H ,8H POPT1 ,8H POPT2.,
, ,	DATA NSTART/3/, IRSIGN/1/, KSTART/11/, FILEIN

	DATA TITLE1/6H ALFA , 6H THETA,6HTHEDOT,6H ALFAR,6HTHETAR,6HTHRDOT
2 E	CJOH B JOH WSC JOHWSCORT/
75	DATA XNAME/8HSCAN NO.,8H K ./,YNAME/8HTHES ERR,8HDEGREES /
	DATA FUNCTN/7HAZIHUTH,7HELEVAT./

	SUBROUTINE	CONTR	l L	73/172	TS	·	FTN 4.6	+452	05/23/79	13.43.02	PAGE 2	•
						•						•
		С										
60		1	GO TO	(100,20	10,300,400,5	00,600,700,800,	900,1000,1100,	1200),ISW -	•			
00		10.	FORMAT	[(9(/))	·							
		11		(1H1)								. 🛨
		C * * * * *				*******	+++++++++					
65		C	,,,,,,,		********	*****	**********					
		100	CONTI					, ,				_
		C THIS	IDENI	TIFIES T	THE SCENARIO	_AND_REINITIAL:	IZES, AS NECESS	SARY.				
		CSIGM	IAE	SNROB.	RHD, FSC, BETA	JM.BMLS	`					
70			IF(NF	IRST) GC								_
				TRUE								
			JBNAM:	Γ≃∙TRUE∙ •Jobname								
			ISIM=4	4		• .					,	
75			IMOD=1									
		110	FORMA	(7,110) 119H1Rt	ISE VS. FSC	STUDY	•					٠
			CALL	LOGIO(61	HFILEIN, FILE	IN,0)						
80			IF (.)	NOT.FILE	EIN) NSTART=	Λ	***					
80					(N) GO TO 12 LTAPE15,DATI	Z ,	***	. , , , , ,	11. ** ** 1			-
			IF(IX	NE 0) (ALL INTIO(6	HIX(AT), IX, 1, 1) SATISFACTORY≠					
			IF(IX	•NE•O) \$	TUPMI¥POTS	ILE ATTACH NOT	SATISFACTORY≠					
85		120	FORMA	(<i>1)</i> 120) [(23H T}	ICALINALIA Al Reads III	-1,2, PUT FILE .2410	5A115FACIURY# /)					•
	•	122	CALL I	LOGIO(6	FILOUT, FILO	UT = 0 }	/), .					
			CALL .	INTIO(6) =NSTART	INSTART, NSTA							
			CALL	THITTOILE	I NSTOP,NSTO							•
90		,	CALL	LOGIO(6H	ATETHRD, TETH	RD • 01		, ,, ,,				
		•	IF(IR	CVR.EQ.]	L) GO TO 125	TV - 0 \					•	
		125	CONTI	NUE NUE	TAUAP I VA AUAP	17707		. , ,				
_					ΓETHR≈2 ,				-			
95				APTV) GO N=-1) TO 135	•						
			IADAP		•	* * *****			• •			
	_	135		NUE		4 mg g - 6 and absorber match		mer e w				
100	•			5 I×2,6	FIDNRS(I)+2							
Ť					ASCI(IASC)	7 Hade Aug. 6 .			•			
		145	CONTI					**				
		150		E(8,150, T(A7,11)		IDASCI(ISIM),I	MOD			معمد جا المور مصمي ويون نا و		
105		220			IDNRS, IMOD	1		' + -	• • • • • • • • • • • • • • • • • • • •	,		
		152			511,1X,11/)							
		153		(153ر7) ار 1H) IDENTS .					***************		
		400		INTIO(6		.15,0}						
110			KSTAR	T=MINO()	KM,KSTART)		.*		,		,	
				= KM-KST/		NUCTA						
			READ	10,105)	LGMAX,(IFS)	:A(I),I=1,LGMAX)			•		
		105	FORMA	T(1415)		** ***)					
			•				•					

	SUBROUTINE	CONT	TRL 7	3/172	TS			FTN 4	4.6+452	05/23/79	13.43.02	PAGE	3
							•						
115			WRITE (7	,106) I	GMAX, (I	FSCA(I),	I=1, LGMAX).						
	1.	06	FORMAT	9HOLGM/	12 = 12	/1H ,13()	17.2811						
			DO 154					/					
	1	54	FSCA(I)	-FSCMIN	N IFSCA (I)							
							()						
120	1	07			7.3,2X))							
			NRUN-NS			~ **	*** ** *** **			.,	· · · · · · · · · · · · · · · · · · ·		
			DSNRDB-								•		
			RHO=0.5				, ., ,,,,						
125			BETA=45	-									
125			BMLS = 1 a BRCVR = 1				*						
			TSEP=1	-									
	1	55	CONTINU		•								
	•	,,	IF(FILE		ro 158								
130			NR UN = NF			• ••							
			WRITE(7						~				
					NRUNAN	RUN, 1, 1)							
						DSNRDB.O.)						
			CALL RE	AL10(6)	RHD,	RHO,01							
135			CALL RE	ALID(6	4 BETA	BETA, 01	M	·					···
			CALL RE	ALIO (SH BMLS	5, BMLS, 01							
		,	CALL RE	ALIO (SH BRÇVE	I, BRCVR, O				منيعة من وص » در عا			
					i TSEP,	TSEP,01							
	_		GOTO 16					-					~ .
140	1	58	CONTINU	JE									
						(KDR) KHU) I	RF W > R U F 2 > R	KCVK) ISEP.			······································		
			IF(EOF(
	· 1					G10.3}		- 1,			,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		
1 / 5	_	.65 .67	TELNOU	CE NC.	IAKIJ GL	TO 158							
145	1	.07	FSC*FSC		IOP) MOR	C= + FALSE	•						····
					2, IAE) -1	reep							
	•	•	XD(3,14		-JIAG/ I	Jul,							
			X0(6, IA										
150			RETURN				- • • •	• ,					
	1	.70		F REACH	IED ON 1	NPUT FILI	E≠						
	C												
	C	***	*******	*****	******	******	******	*******	********	****			
	C	;											
155		00	CONTINU						•				
							A_OF_INTERE	ST, SUCH A	S				
	C	THE				L STATE,							
	_		WRITE(,210)	IRUN , DSN	(RDB, RHO)	BETA, BMLS, B	RCVR, TSEP					
	2	10	FORMAT	SHORRUM	4,5X,6HD	SNRDB 12	X,3HRHO,12X	,4H8E (A) 12	X>4HBMF2>11	.X			
160						10, 14, 6(6)	X • GTO • 311						
			TECNO	• 11100	FNCDOS	442 14.226.01	OUT) IDNRS	140. THOR. 11	MO - MD HM		4 mm/spec pm mmm 1 s		*** * *
		20					AOI1 INKS)	TUOSTHOUST	NO PIRON				
	•		TECHOLI	OTTIVATI	, Il, Al, I	. 1 1 A . 22 A . I	OOUT) IDNRS	. 3 011. 1 000. 1	un				
165	,	30			, [1, [2)		AUDIA TOWKS	YUOY TUOUS	TRUM	, ,,,,,,			
100	2				,,,,,,,, APE17,3L								
			TF(TY.	15.00 C	ALI THTI	יפוצוא	9),IX,1,1)	•					
			IF (1 X -	E OI S	TOP/OUT	UT FILE	REQUEST NOT	SATISFACT	DRY#	200 2 100 000 4 250			
						I), I=1,2					·		
170	2	40					FILE , 2A10) ' - "				,	
•	-	45	CALL DA					•					

	har har 1 (C A) surgests or h h r () 1 dec day h h l dec day of the complete our days decomposition our days decomposition of the complete our days decomposition out days decomposition our days decomposition out days day days decomposition out d
	HRITE (7,250) FUNCIN (IAE), IAE 250 FORMAT (1H0,A7,15H FUNCTION (IAE=,I1,1H)) WRITE (7,260) ((1,X(I)),I=1,8)
175	260 FORMAT (15HOINITIAL STATE://(3H X(,11,4H) = ,G13.6})
	WRITE(7,270) IDENTS(2)
·	RETURN
180	C+++++++++++++++++++++++++++++++++++++
	C
185	C THIS IDENTIFIES THE BASIC RECEIVER STRUCTURE (THRHLD, DPT, SUBOPT) CAND REINITIALIZES, AS NECESSARY, THE FOLLOWING RCVR DATA CIR (NEGATE ONLY), NOAC, NOKLHN, NOLDE, BRCVR, DELBL, TETHRD ITIT=HINO(IRCVR, 2)
	C C NEGATE IR WITH THE FOLLOWING FOR NONADAPTIVE RECEIVER
	C NEGATE IR WITH THE FOLLOWING FOR NONADAPTIVE RECEIVER
190	C
	C
	400 CONTINUE
195	C THIS OUTPUTS BASIC RECEIVER DATA OF INTEREST WRITE(7,410) (IDENTS(I),I=3,4),IR,NG,NS
	410 FORMAT (1H0,A8,4HRCVR/1H0,A8,6HDESIGN/5H (IR=,12,4H,NG=,11,
	WRITE(7,420) (IDENTS(1),1=5,6)
200	' 420 FORMAT(1H0, A8/1H0, A7/)
	C
	č
205	500 CONTINUE C THIS SETS-UP THE MSET-LOOP
	ICOUNT = 0 DO 510 I=1, LGMAX
	YYHI(I)=1.E322
210	510 YYMA(I)=-1.E322
	C
51.5	C
215	600 CONTINUE C THIS SETS-UP THE LG-LOOP FOR THE (HSET)-TH SERIES OF SETS
*	RETURN ,
222	C++++*++++++++++++++++++++++++++++++++
220	C 760 CONTINUE
	C THIS SETS-UP THE K-LOOP FOR THE (LG)-TH-SET OF KM SCANS
225	XO(8; IAE)=2.*PI*FSC
225	X(8)=XO(8,IAE) X(7)=XO(7,IAE)
	DUH-GAUSS(1.0) WRITE(7,11)
	The transfer of the contract o

٠,

	SUBROUTINE	CONT	RL 73/172	TS		*****	F1	N 4.6+452	05/2	3/79 13.	43.02	PAGE	5
			CALL INTID(6H	NRUN, NRU	JN,1,1)								
230			WRITE(7.705)	16.550									
		705	FORMAT(1H .4X			# ,G12.	. 5)						
			CALL INTIO(6H										
			WRITE(7,710)										
		710	FORMAT(6HO	K,4X,5HCS	14RT,4X,5	HQTY ,9)(3X,A6,2)	(3)					
235	,		DO 712 I=1,NS	•									
			EMEAN(I)=0.										
		712	EMS(I)=0. LASTCT=0										
	•		ICOUNT=0		•								
240		-	DD 730 IPA=1,	NC	~ v.	,				, ,u			
240			DO 720 JPA*1	NC									
			PA(IPA, JPA) = 0							·····			
		720	CONTINUE										
		730	CONTINUE										
245			RETURN	. ,			.			bir rates. For an order and the adverse		-	
		C	•							ı			
		C++++	********	******	*****	*******	******	******	*****	·			
		C											•
		800	CONTINUE			44							
250		C THI	S INITIALIZES	THE K-TH S									
			SEP=SPACE					MIN / F+H .	· · ·	,			
		_	RETURN										
		C	********		. a. a. a. a. a. a	ar ar de ar ar ar ar ar	e alea alea de la composição de la composi La composição de la compo						• •
255		C ****	*****	*****	****			· * * * * * * * * * * * * * * * * * * *					
255	•	900	CONTINUE		-	****				·············		······· · ······ ·	
			S SAVES/PREPRO	CESSES DAT	A EROM TI	HE KATH	SCAN						
			IF(ICOUNT.NE.						*			التواليكانات وتسهور إحادب ويلسا لهنة بيث	4 4 10-10-
			DO 905 I-1,NS										
260		905	ES(I)=X(I)-XS	(I)								,	
			IF(NS.GE.7) E	\$ (7) = ABS (X	(7)}-ABS	(XS(7))_							
	• '		IF(NS.GE.8) E	S(8) = ABS(X	7 A L L L A L L	1481811							
			BETTA=(180./P	I)*X(7)	-								
			COL8=THERR										
265			IF (IRCVR , NE										
			IF (IRCVR .EQ										
			IF ((NRUN . EQ . N										
			GO TO 950										
270		906	WRITE(7,910) FORMAT(3HO ,	K) CONKI) (X		421		5086 1 4 1 E		,		* 3 tm - h	
270		910	WRITE(7,920)	1212717 1-1	. NC 1	1211410	1042) TY 11						
		920	FORMAT(18X,5H										A .
		720	WRITE(7,930)			^,,,			•				
		930	FORMAT(18X,5H										
275		,,,,	IF (IRCVR.EQ.1) WRITE(7.	9401 COL	8							
		940	FORMAT(8X,15H						200 2 121 21 1				
		950	XDATUM(K)=K										
		· - •	THESER (K) = THE	RR	,,,								• , .
			LASTCT-ICOUNT										
280			IF (K.LT.KSTAR										•
			DØ 960 I=1,NS						#***	come & No. 1 City April 1 States			
			EMEAN(I) = EMEA	N(I)+ES(I)									
		960	EMS(I)=EMS(I)	+ES(1)**2	*** *******				, ,				
		_	RETURN	•									
285	•	Ç											

	, , , , , , , , , , , , , , , , , , , ,
	C*************************************
	C
	1000 - 00071805
	C THIS SAVES/PROCESSES/OUTPUTS DATA FROM THE (LG)-TH SET OF KM SCANS DO 1005 I=1,NS
290	DO 1005 Tw1.NS
270	EMEAN(I) = EMEAN(I) / KHNET
	EMS(1)*EMS(1)/KMNET
	ERMS(I) = SQRT(EMS(I) + EMEAN(I) + +2)
•••	
295	1005 CONTINUE
	XH=ICOUNT
	TCOUNT=100.+XW/KM
	WRITE(7,1009)
	1CO9 FORMAT(3(/))
300	WRITE(7,1010)KMNET
	1010 FORMAT(5x,26HERROR SAMPLE STATISTICS: (,13,9H SAMPLES))
	IF (IRCVR.EQ.1) WRITE (7,1015)
	1015 FORMAT(5x, 31HTHRESHOLD RCVR (FILTERED ERROR))
	WRITE(7,1020)(TITLE1(1),I=1,NS)
305	1020 FORMAT(1H0,20X,4H0TY,9(3X,46,2X))
,	WRITE(7,1030) (EMEAN(I), I=1,NS)
	1030 FORMAT(1H0,16X,8HEMEAN = ,9(G10.3,1X))
	WRITE(7,1040)(ERMS(I),I=1,NS)
016	1040 FORMAT(18X,7HERMS = ,9(G10.3,1X))
310	WRITE(7,1050)(ESO(I),I=1,NS)
	1050 FORMAT(19X,6HESD = ,9(G10.3,1X))
	IF (IRCVR.EQ.1) WRITE (7,1060) TCOUNT
	1060 FORMAT(//1H ,4X,F7.2,22H% OF SCANS ARE ABORTED) 1F(IRCVR.NE.1)WRITE(7,1070)(GQGT(I,I),I=1,NS)
	IF(IRCVR.NE.1)WRITE(7,1070)(GGGT(I,I),I=1,NS)
315	1070 FURMAT(5(7),4X,35H ON LAST SCAN, DIAGONAL OF GQGT WAS/26X
	C9(G10.3,1X)) DD 1071 I-1,NS
	DO 1071 I=1,NS
	EEMEA(LG,I)=EMEAN(I)
	EERMS(LG,I) = ERMS(I)
320	1071 EESTD(LG,I) = ESD(I)
	DD 1072 I=1,KM
	YYMT/1 C1#AMTN1/TUECED/T1. YYMT/1 C11
	1072 YYHA(LG)=AHAXI(THESER(I), YYHA(LG))
	TICELED-TENDAL THESERIES (TRACES)
325	TTCD(LG) =TCDUNT IF(LG.NE.1) RETURN
323	
	YHIN-YHAX-O.
	WRITE(7,11)
	CALL INTIG(6H NRUN, NRUN, 1, 1) CALL PLOTR(XDATUM, THESER, KM, XNAME, YNAME, YMIN, YMAX, 0) DETION
	CALL PLOTR(XDATUM, THESER, KM, XNAME, YNAME, YNIN, YMAX, O)
330	NEIVAR I I I I I I I I I I I I I I I I I I I
	C ,
	C+++++++++++++++++++++++++++++++++++++
	C
	1100 CONTINUE
335	C THIS SAVES/PROCESSES/QUIPUTS DATA FROM THE (MSET)-TH SERIES OF
•	CLGHAX SETS OF KM SCANS
	WRITE(7,11)
	CALL TATTOLEH ADIN.ADIN.3.15
	UDITE(7.1310) AU CC . (TTICI(13.401)
340	CALL INTIO(6H NRUN, NRUN, 1,1) WRITE(7,1110) 6H FSC (TITLE1(1), I=1,NS) 1110 FORMAT(1H0,10X,3HQTY ,9(3X,A6,2X))
UPG	ALLY FUNDALLINGSLUGGEDINI SYLONAGASIS
	WRITE(7,1120)FSCA(1), (EEMEA(1,1),I=1,NS)
	1120 FORMAT(1HO, 7X,7HEMEAN; ,9(G10,3,1X1)

	SUBROUTINE CONT	RL 73/172	τς) pp = 0	FTN 4.6+452	05/23/79	13.43.02	PAGE	7
	•	DO 1130 J=2,	LGMAX			HE SCHAMOSHARA MICTORY TOPOGRAPH			
345	1130	WRITE(7,1161) FSCA(J), (EEM	EA(J,I),I=1,	NS)	•			
343	1140	FORMAT(1HO,	8X,6HERMS: ,9((G10.3,1X))					
	1150	00 1150 J=2,	LGMAX) FSCA(J), (EER	HC (T) . T = 1 .		, , , , , , , , , , , , , , , , , , , ,			
		WRITE(7,1160) FSCA(1), (EES	TO(1,I),I=1,	NS)				,
350	1160	FORMAT(1HO, DO 1165 J=2,	8X,6HESTO: ,9(G10.3,1X))					
	1165			TD(J,1),1-1,					
	1161	FORMAT(15X,9 DO 1103 I=1,	NS						
355		FACTOR=1.				****** ***** * *** ***			
•		1F(1.EQ.7) F	ACTOR=180./PI ACTOR=.5/PI						
		TE(T.FO.Q) F	ACTOR=-5/PT						
360		YMIN=O. YMAX=O.	****		The managed is adopted to an allow a believe to		I		
	1101	DO 1161 LG1=	1,LGMAX		,		······································		
	1101	YNAMEL(LGI)=EE	RMS(LG1,1)*FAC AM1(1,1)	HUK	e a communication of the form				
365		YNAME1(2) = YN	AM1 (2, I)			•			
309		K1=MOD(I,2) IF(K1.E0.1)W	RITE(7,11)		,				
		IF(K1.EQ.1)	CALL INTID(6H	NRUN, NRUN, 1	د ۱۱ د.				
		CALL PLOTE (F	SCA, EEHE, LGHAX	,XNAME1,YNAM	EL, YHIN, YHAX, O)		<u> </u>		
370	, 1103	CONTINUE	IITA DETIION				~ ♀ ♀		•
	-	WRITE(7,11)		4 H-M PM	a ne s'anti misma a bar man s' dudi i	. *** ` ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' '	95		
	1170	WRITE(7,1170 FORMAT(13H O) (DATBUT(I),I UTPUT FILE ,2A	*1,2) 10,1H:/)			7		
375		WRITE(7,1172) DOUT, DELT, MT	IMES LGMAX, K	MATODAY, JBNAH	V. BEF 55 AT BESSEL & AMELIA			
	1172	WRITE(7,1174	10,8X,G13.6,5X 1DENTS,KSTAR	,3(5X,13,10X T	(M,TODAY,JBNAM (),A10,8X,A10/)		<u> </u>		
	1174	FORMAT(1H ,6	(1X,A8,9X),6X,	[3/)	TEED		E.		
380		FORMAT(1H ,5	X,12,6X,6(5X,G	13.6)/)			7	,	
	1175	DO 1175 LGN=	l.LGMAX N eeme(!GN).ee	DM/I GNA.EEST	(LGN),TTCO(LGN),YYH	7/1/W.			
					TEGRITAL PRES.	1 Def 2 142-00		. may began y	. - •
385	1182	FORMAT(1H)7 WRITE(17) DO	(G13.6,5X),I5) UT.DELT.MTIMES	.LGMAX.KM.TO	DAY, JBNAH				
	••	WRITE(17) 1D	ENTS.KSTART						
		DO 1190 LGN=		ETA, BMLS, BRC	VR, TSEP ,			** ******	•
200	1190	WRITE(17) EE	ME(LGN), EERM(L	GN), EEST (LGN	I),TTCO(LGN),YYMI(LG	N),	e rela ever bean me roma ma		
390		*YYMA(LGN),FS IX=IATTACH(6	CA(LGN), LGN LTAPE20, DATOUT)	ت نتر وقد سخده خو شعفه بخشته المشاهدة المقا عود عد				
		TEITY.NE.A)	CM TM 1108		UM				
		CALL RETURN(6LTAPE20)	's Y nou à nou à Yn					
3 95		REWIND 17	TAPE17-NATOUT	. 21 PW. SPUTCH	FILL, 2LRP, 365)	1 198 09-7 (5	ne detect 1 . He are subjectively and	, 1=	14
		GO TO 1196		* TELBYOKHION			- 4		
	1195	CALL RETURN(REWIND 17							
		, , , , , , , , , , , , , , , , , , , ,		1		, ,			

				/172	10	, ,	FTN 4.6+452	93/23/19	13.43.02	PAGE	•
400						TOUT, ZLXR, 8RHIGHF	ILL, 2LRP, 365)				
			IF(IX.NE	.01 S		(6HIX(CA),IX,1,1) T FILE CATALOG NO	T SATISFACTORY#	3 A 84		-1 (re most 7)	
405						(1), I=1,2) ,2A10,33H IS WRI	TTEN, CATALOGED AND	CLOSEO)			
		С	RETURN								
		C+++++ C	*******	****	*******	********	*******	*******			
410		C THIS		CLOS	URE OF TH	E SIMULATION RUN				والمحمد والمحم	
			WRITE(7, RETURN	11}		•				_ +	•
415		Č****	******	****	******	*****		*****			
		C	END			•		· ·	* * *****		
50001	CH STORAG	E USED		13.05	4 SECONDS		•	- u .			

SUBROCTINE CONTRL"	73/172 15		FTN 4.6+452	05/17/79	17.19.25	PAGE	1
SUBR	OUTINE CONTRL(ISW)			,			•
·	•				14 14 H		٠.
	NOUCTS THE MLS SIME	NTYLION LHKONGH Ÿ 🖺			,		
THE TENTE VS.	FSC STUDY .						
······································	14 NO. * * * * * * * * * * * * * * * * * * *						
	GER XNAME1(2), YNAME	E1 (2) - VN ART (2. 0)					
	GER XNAME(2), YNAME		(43.DOUT				•
	GER TITLE1(9), FUNC						
			IRD, MORE, NFIRST, ADAPTV,	N 5 B			
	IN, FILOUT				•		
	ON/IDDATA/ISIM. IPMI						
	UN/RCVROO/THAMAX, TE						
	ON/RCVRO1/NGMIN,NG						
	UN/RCVROZ/RHOMAX,O				,		
	ON/RCVR03/PI,F(8,8 UN/RCVR04/DELT,EO(
			RDIAG(5),PHDIAG(8)				•
	ON/RCVRO6/PPDIAG(8				l l		
	ON/RCVR07/T(130),V		, , ,	••	••	•	
	ON/RCVROS/XSLOE(8)						
	UN/RCVRO9/BRCVR, BB;	PDCRIT,CC		••••			
	DN/RCVR10/XS1(8),X						
	UN/MLS000/ALFA, THE						
	ON/MLSUU1/CSNRT,CSI		I, FSC, LGMAX				
	DN/MLS002/DCSNR,CSI DN/MLS003/FL10AE(4		21.40/0.21.40/4.21				
	ON/MLSOU4/BMLS,BBB		-				
	NSION X(8), THESER(ME(13).FFRM(13)	<u> </u>			
			EST(13), TTCO(13), YYMI(1	.3)		*** * *	
DIME	(EI)AHYY NOIZA			<u>8</u>	<u>≅</u>		
	NSION FSCA(13), IFS			· · · · · · · · · · · · · · · · · · ·	Z	٠,	
	NSIUN EEMEA(13,9),		13,9)		₽		
	NSION EMEAN(9), EMS		. FCDUC/1.311		• • • • • • • • • • • • • • • • • • • •	-	
_ · · · ·	VALENCE (EEME(1),E: T(1),EESTD(1,2)}	eut Withen in Teckulti	SEEKU2(T)511)	· · · · · · · · · · • · • • • • • • • •			
	VALENCE (THERR, ES (2	3.3		⊂	*		
	VALENCE (ALFA, X(1)		DOUT, DATOUT(2))	≥	.,@i		
	YNAM1/8HALF RMSE,		ISE, BHDEGREES		1,9		
	T RMSE, 8HDEG/SEC',		•8HTHR RMSE• ""	· 2	77		
	GREES , 8HTRD RMSE,			1837	<i>7</i> 7	. ,	
	C RMSE;8H ' HZ ' ,1						
	. ABORT/1HA/,SPACE/: . DATIN/10HMLSSIMOA						
	DATTUT/10HMLSSIMD		-07				
	"IDASCI/7HCROSSMP"		.7HRHSE(F).7H	ú, •== ·			•
	MLS1 , 8H PMLS2 ,	1	, , , , , , , , , , , , , , , , , , , ,	•			
*8H" P	MLS3 " SHTTHRHLD ,	8H'OPTIML";8H"SU8OA	T ,8H -3 DB ,8HADAPTIV	r ,			
		BHTETHERED, 2H , 8H	POPT1 ,8H POPT2 ,				
	OPT3 -/ "			• • •	•		
	NSTART/3/, IRSIGN/		(N				
	LSE./,FILOUT/.TRUE		I ALERAN CHITHERAN CHECON	· · · · · · · · · · · · · · · · · · ·			
DATA	61 B ALFA 64 TWSC 61 . 64 B ALFA 64 TWSC 61 .	n intiajonintuuijoh Renotjaan	ALFAR, 6HTHETAR, 6HTHRDC	/			
	XNAME/BHSCAN NO.		SHTHES ERR, 8HD EGREES /				
		8H " HZ /" " "	, , , , , , , , , , , , , , , , , , ,				
	FUNCTA/7HA2TRUTH						

	300KBC/INE	CONTRI	13/115 13		FIN 4.0+452	05/1///9	17.19.25	PAGE	2
		c							-
		· · ·	60 ŤO (164,200,300,400,500,600	,700,800,900,10	00.1100.12001.ISW				
60		1 1	FUPMAT(IH)		,				
		10	FGRMAT(9(/))						
		11	FORMAT (1H1)						
65	-	C	· · · · · · · · · · · · · · · · · · ·	*******					
		7	CONTINUE			•			
			IDENTIFIES THE SCENARIO AND R	EINITIALIZES. A	AS NECESSARY.				
		CTHE F	DLLOWING RECEIVER PARAMETERS						
			, IAE, DSNRDB, RHO, FSC, BETA, JM, BM	LS TIPE	· · · · · · · · · · · · · · · · · · ·				,-
70			IF (NFIRST) GD TO 155						
			NGAC *.TRUE.	-, , ,	• •				
			NFIRST=.TRUE. JBNAM=JD8NAME{I}^^~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~						
			• • • • •						
` [~] ~75			\$ 00MI				** *******		٠.
			WRITE (7,116)						
			FORMAT(19HIRMSE VS. FSC STUDY)			-		•	
			CALL LOGIO (6HFILEIN, FILEIN, 0)		_				
0.0			IF (.NUT.FILEIN) NSTART=0		•	,			
80			IF(.NOT.FILEIN) GO TO 122 IX=IATTACH(6LTAPE15.DATIN)						
			IF(IX.NE.O) CALL INTIC(6HIX(AT	1.17.3.11					
			IF(IX.NE.G) STOP≠INPUT FILE AT		ACTORY#				
			WRITE(7,120) (DATIN(I),1=1,2)						
~ ~85		120 7	FORMAT(23H THIS READS INPUT FI	LE ,2A10/) " '				-f- 4,14	
****			CALL LOGIO (6HFILOUT, FILOUT, 0)						
	,		CALL INTIO(6HNSTART, NSTART, 100	(04)			* C.		
			NSTOP*NSTART CALL"INTIO(6H"NSTOP,NSTOP,100,	01				-	
90	ı	i	CALL LOGIO (6HTETHRO, TETHRO, 0)	01		•		•	
+ 4	** *** *** *	', '	IF(IRCVR.EQ.1) GO TO 125				.,		
			CALL LOGIO(6HADAPTV, ADAPTV, 0)				7	,	
			CONTINUE						
95			IF(TETHRD) ITETHR=2			.,			
45			IF(ADAPTV) GQ TO 135 ' .~~ IRSIGN=-1		• •		•		
	•		1ADAP=3						
			CONTINUE '		,	_	•		
•			DU 145 I=2;6 ^~~~~))	**************************************			,	
100			IASC=3*(I+1)+IDNRS(I)+2						
•			IDENTS(I)=IDASCI(IASC)						
		145	CONTINUE						
		150	ENCODE(8,150,1DENTS(1)) IDASCI FORMAT(A7,11)	(121W) 1 MOD					
~105			WRITE (7,152) IDNRS, IMOD	#4= = 40 hr5mm					
			FORMAT (1H ,611,1X,11/)						
			WRITE (7,153) IDENTS				•		
1			FORMAT (1H , A8)						
110			CALL INTIO(6H KM,KM,115,0)	/ / *******	•				
110			KSTART=MINO(KM,KSTART) KMNET=KM-KSTART+1	~~~,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,					
			FSCMIN=1./(DELTAT(IAE)+KMNET)						
•			READ(10,105) LGMAX,(IFSCA(1),1	=1.LGMAX) ' "					
			FORMAT(1415)	_, _, _,,,,,,,		•			
		,	the distance of the Administrative supportance when your angest in the						

•-	SUBROUTINE CON	TRL 73/172 TS		• •• •	FTN 4.6+452	05/17/79	17.19.25	PAGE	3
115	**** * ***** **** * ***	#RITE(7,106) LGMAX		IGMAY)		,			
. **/	1.106	FORMAT(9HOLGMAX =)			a 4 4 14	• • • •		• • •	
	***	DO 154 I=1, LGMAX	, , , , , , , , , , , , , , , , , , , ,	,		•			
	154	FSCA(I) *FSCHIN+IFSC	A(I)						
		WRITE(7,107) (FSCA()							
- 120	107								• •
		NRUN=NSTART-1				_			
•	• / •	DSNRDB = 20.	•	• •		-	2 m, , , , ,		
		RHG=0.5							
	•	BETA*45.	,						
1,25		BMLS=1.							
		BRCVR=1.							
	100*	TSEP=1.							
	155	'CONTINUE' IF(FILEIN) GOTO 158	a						
" 130		"NRUN=NRUN+1							
150		WR1TE(7,11)							
		"CALL INTIO(6H 'NRUM	N.NRUN.1.1) '""		** * ** * * * * * * * * * * * * * * * *		***********		•
		CALL REALIDIGHDSNR					į.		
			10, RHO, 0)	•		• • • •		•	
135			TA, BETA, U)					t.	
		CALC REALID 16H BM		•• •			. 1404		
		CALL REALIG 16H BRO							
• ••		" CALL REALID(6H" TSE					************	• •	
		GOTO 167				•			
140	158	'CUNTINUE	• •		•	•		•	
		READ(15,160) NRUN, (SNRDB, RHO, BETA	, BMLS, BRCVI	R,TSEP				
••• •••		"'IF(EOF(15))170,165		•				• •	
	, 160	FORMAT(15,3G10.3,5)	(,3G10.3)				~ O>		
	165	IF (NRUN.LT.NSTART)	GD TO 158 `~ '	, t- t man-11).			1 72 T		
145	167	IF (NRUN.GE.NSTOP) /	MORE=.FALSE.					_	
		""FSC=FSCA(1) " " "					· · · · · · · · · · · · · · · · · · ·	• ,	
		XO(5, IAE) = XO(2, IAE)	-TSEP				POOR		
•• •		- XO(3, IAE) - C1	,						
		XO(6, IAE)=0.	, ., , ,, ,,						
` 150		"TRETURN	A THRUT CYLCA				~ ~		
	170	STUPFEOF REACHED OF	A THANK LIFER				とえ		
	(, , , ,					4444	三三 宣帝		
	C "	*****	• • • • • • • • • • • • • • • • • • •	-	· • • • • • • • • • • • • • • • • • • •		E'''		
155	•	CONTINUE					7 ::	S :.	
		IS OUTPUTS BASIC SIM	HATTON DATA DE	'INTEREST.	SHUH YS , ,		····	*	
		ANGLE FUNCTION, INI			30011 #3		•		
		WRITE(7,210) NRUN,			O.TSED	~ 1 4.			
	210	FORMAT (SHONRUN, 5X)				111.			
- 150		*5HBRCVR, 12X, 4HTSEP			octapacity thomesay	· · · · · · · · · · · · · · · · · · ·	· ·		
		IF(.NOT.FILOUT) GOT							
		"IF(NRUN.LET9) ENCO		IDNRS.1HU	· IHDD · 1HO · NRUN				
	220	FORMAT (611, A1, 11, A							
		IF (NRUN; GE.10) ENC) IDNRS . 1H	U.IMOD.NRUN ""				
165	230	FORMAT(611,A1,11,11		•					
		IX-IREQST(6LTAPE17:	,3L*PF)	• • • • • • • • • • • • • • • • • • • •					
		IF(IX.NE.O) CALL II		X,1,1}					
•		TIF (IX.NE.O) 'STOP#O	UTPUT FILE REQU	EST"NOT' SA	TISFACTORY≓ "				
		WRITE(7,240) (DATO							
170			ITES OUTPUT FIL	E ,2410)		•			
	245	CALL DATE (TODAY)							
					· · ·				

- "" SUBRO	UTINE CONTRL "73/172" TS	FTN 4.6+452	05/17/79 17.19.25 PAGE 4
	W	was made to be the second of the property of the second of	
	HRITE (7,250) FUNCTN (IAE), IAE 550 FORMAT (1HG, A7, 15H FUNCTION (IAE=, 11, 1	н))	
175	WRITE (7,260) ((1,X(1)),1=1,8) 260 FORMAT (15HOINITIAL STATE://(3H X(,11,		
	270 FORMAT(1HO, AT)		ya wa ang ang ang ang ang ang ang ang ang an
	RETURN	•	
180	C	*******	*
	300 CONTINUE	DE PENDULA ART CHARTS	
185 "	C THIS IDENTIFIES THE BASIC RECEIVER STRUCTI CAND REINITIALIZES, AS NECESSARY, THE FOLLOW CIR (NEGATE UNLY), NUAC, NUKLHN, NULDE, BRCVR, I ITII-MINO(IRCVR, 2)	ING ROVE DATA	
	. C	• ,	
, ,	C NEGATE IR WITH THE FOLLOWING FOR NONADAPT: IR=ISIGN(IR,IRSIGN)	VE RECEIVER	10) (• (14 • 144) pain and recommend the recommend of the re-
.190	C RETURN		
	C		
	C+************************************	`***********	•
195	C THIS OUTPUTS BASIC RECEIVER DATA OF INTER WRITE(7,410) (IDENTS(I),1=3,4),IR,NG,		* * 100
,	410 FORMAT (1HO,A8,4HRCVR/1HO,A8,6HDESIGN + 4H,NS=,II,1H))		
200	WRITE(7,420) (IDENTS(1),1=5,6) 7 420 FORMAT(1H0,48/1H0,47/)		
	C	Maller er e d e e en 1, mar 1 p. 100 100	- A
u	. C++++++++++++++++++++++++++++++++++++	********	**
205	- 500 CONTINUE ' "		
	C THIS SETS-UP THE MSET-LOOP	ν torcitistands de μι σε	The state of state of the state
	DO 510 I=1,LGMAX YYMI(I)=1.E322	*	The state of the s
210	51U YYMA(I) =-1.E322 RETURN	•	
	C++++++++++++++++++++++++++++++	*******	and a summarism of the second control of the second second control of the second secon
	Ċ		
215	C THIS SETS-UP THE LG-LOOP FOR THE (MSET)-T	H SERIES OF SETS	
•	RETURN		
	· C+*+*********************	*******	k#
220	C 700 CONTINUE TTT.		
	C THIS SLTS-UP THE K-LOOP FOR THE (LG)-TH S FSC=FSCA(LG)	ET OF KH SCANS	
	XO(8, IAE)=2.*PI*FSC	walling and the second	up gai niệth hiện CHR ĐIĐ P V ni (
225	X(0)=XO(0,IAE) X(7)=XO(7,IAE)	- 45 6 7 7	
	DUM=GAUSS(1.0) WRITE(7,11)		

SI	UBROUTINE CONT	RL 73/172 TS PAGE 5
***		The same of the sa
*005		CALL INTIG(6H NRUN, NRUN, 1,1)
1230	265	WRITE(7,705) LG,FSC
	705	FORMAT(1H)4X,3HHG=,12,5X,6HFSC = ,G12.5)
		CALL INTID(6H 'KMyKMyI,1)
	710	WRITE(7,710) (TITLE1(1),1=1,NS) FORMAT(6H0 ' K,4X,5HCSNRT,4X,5HQTY ",9(3X,A6,2X))
235	110	DO 712 I*1,NS
		EMEAN(1)=0.
	712	EMS(1)*0.
		LASTCT*0
	,	ICOUNT=0
·** 240 ** ·		DO 730 IPA-1,NS
		DO 720 JPA=1,NS
	1 404 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	PA(IPA, JPA)=0.
	720	CONTINUE
~ ~ ~	730	CONTINUE
245	.	RETURN
	C	
	C****	
		CONTINUE
250	800	CONTINUE S INITIALIZES THE K-TH'SCAN
200	C In	SEP*SPACE
		RETURN
	c	RETORN
	· · · · · · · · · · · · · · ·	***************************************
255	Č	一个
		CONTINUE
	C THI	CONTINUE S SAVES/PREPROCESSES DATA FROM THE K-TH SCAN "IF (ICOUNT.NE.LASTCT) SEP=ABORT XS (7)=0.59+P1 XS (8)=0.60
		"IF(ICOUNT.NE.LASTCT) SEP=ABORT
		XS(7)=0.5*PI
260		"TXS(8)=0.0" " " " " " " " " " " " " " " " " " "
- , ,	905 -	ES(1)=X(1)-XS(1)
		IF(NS-GE-7) ES(7)=ABS(X(7))-ABS(XS(7))
		"IF (NS.GE.8)" ES (8) = ABS (X(8)) - ABS (XS(8))
265		
		"COL8 *THERR'
		IF (IRCVR .NE. 1) COL8=SQRT(PPDIAG(2)) IF (IRCVR .EQ. 1) CALL DFLTR1(COL8, THERR, FL10)
		1F((NRUN.EQ.NSTART.AND.LG.EQ.1).OR.(K.EQ.KK)) GOTO 906
. 270		- GD TD 950
210	906	WRITE(7,910) K,CSNRT,(X(I),I=1,NS)
	910	
		WRITE(7,920) (XS(I), I=1,NS)
•	920	
275		WRITE(7,930) (ES(I),I=1,NS).
1	930 .	FORNAT(18X,5H ES* ,2X,9(G10.3)1X))
		IF(IRCVR.EO.1) WRITE(7,940) COL8
	943	FORMAT(8X,15HUNFILT. ES(2)= ,13X,G10.3) ""
	950	XDATUN(K)=K
280	• •	THESER(K)=THERR
		LASTC1=ICOUNT
	.,	TIF(K.LT.KSTART) RETURN
		DU 960 I=1,NS
		** EMEAN(I) = EMEAN(I) + ES(I) *** - *** - *** - *** - *** - *** - *** - *** - *** - *** - *** - *** - *** - **
285	960	EMS(I)=EMS(I)+ES(I)**2

SOBKOUTT	HE CONTPL	73/172 75	FTN 4.6+452	05/17/79 17.19.25	PAGE	6
	. ,		The a second of the second of the second of			
	RET	URN	,	* ** *		
	C + + + + + + + + + + + + + + + + + + +		******			
	C		********	*		
290	1000 CON	TINUE			,	
	C THIS SA	VES/PROCESSES/OUTPUTS DATA FROM THE	(LG)-TH SET OF KM SCANS	72 1 2 2 22 22 22 22 22 24 24 24 24 24 24 24		-
		1005 1=1,NS	-		_	
		AN(I) = EMEAN(I) /KMNET	•			
295		(1)=EMS(1)/KMNET	• • •			
473		S(I)=SGRT(EMS(I)) (I)=SGRT(EMS(I)-EHEAN(I)++2)				
Production of the same	1005 CON	TINUE		والمستحدة والمداعة فالمستحد المحالب والدر المدد وبوارا		
		ICOUNT				
•		UNT=100.*XW/KH		, . , m 11 - , . t	•	
300		TE(7,1009)				
		MA1(3(/))				
7 BV 4/4 4/4 4/4		TE(7,1010)KMNET Ma1(5x,26HERROR SAMPLE STATISTICS: (. Ta.ou CAMPIECTS "" .			
		IRCVR.EQ.1) WRITE (7,1015)	, 13, 711 JAIN ECS / 1			
305		MAT(5X,31HTHRESHOLD RCVR (FILTERED E	RROR))			
		Tr (7,1020) (TITLE1(I), I=1,NS)			•	
		MAT(1HU, 20X, 4HQTY , 9(3X, A6, 2X))	•			
		TE(7,1030)(EMEAN(I),I=1,NS) MAT(1HU,16X,PHEMEAN = ,9(G10.3,1X))				
310		TE(7,1640)(ERMS(I),I=1,NS)				
		MAT(18X,7HERMS = ,9(G1G.3,1X)) ""	waxy 2 xy +		•	
		TE(7,1050)(ESD(I), I=1,NS)				
,		MAT(19X,6HESD = ,9(G10.3,1X))	wine shart , , , , who u	1 4 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	•	
		IRCVR.EQ.1) WRITE (7, 1060) TCOUNT				
" 315 ' "" '		MAT(//1H ,4X,F7.2,22H%				
		MAT(5(/),4x,35H ON LAST SCAN, DIAGON			· ,	
		10.3,1X))		•		
	DO	1071 I=1,NS'	4- PM 4	nn 13 - 41	•	
320	M39	EA(LG,I) =EMEAN(I)		e w × 1 tackwhitely problems were set on the tack		•
		MS(LG,I)=ERMS(I)				
		TO(LG,I)=ESD(I) 1072 I=1,KM				
^ 325 · ·	™ 1072 YYM	<pre>II(LG)=AMIN1(THESER(I),YYMI(LG)) IA(LG)=AMAX1(THESER(I),YYMA(LG))</pre>			Pat-	
	TTC	O(LG) = TCOUNT				
		LG.Ne.1) RETURN			-	-
		(N=YMAX=Q.	,	4+ M		
330		TE(7,11)				
	CAL	L PLOTR(XDATUM, THESER, KM, XNAME, YNAME	YMINAYMAXAO) " "			•
	RET	URN				
m) nv = ====	C				• •	
	C * * * * * * * *	**********	*****	**		
335	1106 006					•
	1100 CON	VES/PROCESSES/OUTPUTS DATA FROM THE	(MSET)-TH SERIES DE			
		TE DE VA COLUE	***************************************			
•••		(TE(7,11)		، بسبب یا مصنوعات موسعه مدا مودانشتهای سی جو بر پیر پ د		
340		L INTIO(6H NRUN, NRUN, 1, 1)				
	WRI	TE(7,1110) 6H FSC ,(TITLE1(I), I=1,N	5)			
	. TTÍO 'EOH	MAT(1H0,10X,3H0TY ,9(3X,A6,2X))				

	200KHOLINE CE	INIKL	73/1/2 15		FIN 4.6+452	05/17/79	17.19.25	PAGE	7
345		C FORMA DU 11:	(7,1120)FSCA(1),(T(1HG, 7X,7HEMEAN BG J=2,LGMAX	: ,9(G10.3,1X))	•				
	- 113	30 WRITE WRITE	(7,1161) FSCA(J), (7,1140) FSCA(1),	(EEMEA(J,I),I=1,1 (EERMS(1,I),I=1,1	NS)		•	•	
	114	O' FORMA' DO 11	T(1HO, 8X,6HERMS: 5G J=2,LGMAX	,9(G10.3,1X))					
350	115	O WRITE WRITE	(7,1161) FSCA(J), (7,1160) FSCA(1),	(EERMS(J,I), I=1, ! (EESTD(1,I), I=1, !	(S) — -		****		
•	116	00 FORMA	T(1HO, 8X,6HESTD: 55 J=2,LGMAX	,9(G10.3,1X))		.			
355		1 FORMA	(7,1161) FSCA(J), T(15X,9(G10.3,1X)		(\$)				,
		FACTO							
360	M # 14 T41 B-4M PB MAP #	IF(I.	EQ.7) FACTOR=180. EQ.8) FACTOR=.5/P EQ.9) FACTOR=.5/P	I					
500		×NIMY = XAMY).		,		. 1		
	110	00 110	l LGI=1, LGMAX .G1)=EERMS(LG1,I)	*FACTOR "					
. 365		YNAME:	L(1) = YNAM1(1,1) L(2) = YNAM1(2,1) "		, , m m.,		يو چې پېښې د لوه فعلما کارل په		-
•		IF(K))(1,2) .EQ.1)WRITE(7,11) .EQ.1) CALL INTIO						
- 37c		IF	(K1:E0.0) WRITE(7	•1G) *				•	
	1,110)3 CONT I)	NUE " " ". OT.FILOUT) RETURN		ે અના માં તે જીવનથી જાજાર	15th Alba dd - an Aran al - was recover conserve	, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		•
375	117	WRITE	(7,11) . (7,1170) (DATOUT(((13H OUTPUT FILE	I),I=1,2)				•	
-	117	72 FORMA	(7,1172) DOUT,DEL' ((1H ,A10,8X,G13. (7,1174) IDENTS,K	6,5X,3(5X,I3,10X)	AANAL (YADOT el (\OLA\X8,010/)		· reservence (* sous e s. p.	•	
380	117	4 FORMAT	[(1H ,6(1X,AB,9X), [7,1176] NRUN,DSN	6X, I3/) "	. T C G D		و ټاه معمد		
•	117	'6 FORMAT	[(1H ,5X,12,6X,6() 75 LGN=1,LGMAX	5X,G13.6)/)	, 1341	· ·			
385		75" WRITE			(LGN),TTCD(LGN),YYK	I(LGN),	·		•
	118	WRITE	T(1H ,7(G13.6,5X), (17) DOUT,DELT,MT	IMES, LGMAX, KM, TO	DAY. JBNAH				
3 90	A * 100 A \$100 P T T A	WRITE	(17)~IDENTS,KSTAR (17)NRUN,DSNROB,RI		/R.TSEP		,	DP #	
		WRITE	90 LGN=1,LGMAX (17) EEME(LGN),EEI LGN),FSCA(LGN),LGI		TTCO(LGN),YYMI(LG	٧),			
	W	IX=IA	TACH(6LTAPE20,DA NE.O) GO TO 1195	TOUT)					
. 395		READ (2G) DUM, DUM, IDUM, : RETURN (BLTAPE2O)	IOUM, IOUM, DUM, IDU	JM ·	e day y a u su s dayeeyd by'r d	tamenda to the transfer		
-	 •	REWIN) 17 ATALD(6LTAPE17,DA		:ILL,2LRP,365)	<i>:</i>			
					_				

SUBROUTIN	E CONTRL	73/172 TS	•		FTN 4.6+452	05/17/79 17.19.25	PAGE 8
							.,
400		L RETURN(6LTA	PE 20)				
		IND 17				,	
• •				R, BRHIGHFILL, 2	LRP,365)		
			INTIO(6HIX(CA		************		
435	·· · · · · · · · · · · · · · · · · · ·	L RETURN (6LTA	PF171	WINTOR MOI SYL	ISPACIURTE,		
	WR1	TE (7,1198) (DATOUT(I),I=1,	2)			
					CATALOGED AND CLD	SED)'	
_	RET	URN	_	_			
/10	C		- 				
410	C *******	*****	******	****	***********	**	
	1200 CON	TINUE					
•			OF THE SIMULA	TION RUN			
		TE(7,11)		, and the same of			
···· 415 · · · ·	RET	URN' - ' -					* *
	C			********			
	(********	*****	*******	*******	************	**	
******	, END						
	2112	-					•
" 45000B CM STORW	AGE USED '	15.561 S	ECONDS				• •
			*** ***		M		

	SUBROUTINE CO	NTRL	73/172	TS				* FTN 4.	6+452	•	05/18/79	13.52.38	PAC	E	1
		 Subro	UTINE CO	NTRL(ISW)						m => ++ +4		- m-,		-	•
4	6						, -	-					٠.		
	č	THIS CON	DUCTS TH	E HLS SIN	ULATIO	THROUGH	i A				•				
			THETA S			· IIIKGOO!	, ,		-		-	•			
5	č ''		***********												
· - -		* "REAL	LAHDA "												*** * **
				1(2), YNAP	E1(2).	/NAH1(2,9))								
-				(2),YNAME				DOUT	** *						
				1(9), FUNC											
- 10	Iv			N, NOLDE, N		MAN, LOE,	TETHRO	MORE, NEI	CRST.AC	APTV. "					
			N, FIL DUT						•						
		' С В М М В	N/IDDATA	/ISIM, IPM	LS, IRC	/R, IADAP,	ITETHR;	IPOPT						,	~ **
		COMMO	N/RCVROO	/THAHAX,T	HAHIN,	rs, TR, OME	GA, TF		,						
				/NGMIN, NO					•				•		
15		CONNO	N/RCVRO2	/RHOMAX, C	THO, TO	RD, BD, WSC	D, NSO (4) , NGD (4))						
• •		"" COMMO	N/RCVR03	/PI,F(8,8	1),FL25	(4),FSAHF	, K , KH , T	ETHRD, NO	S, NS, JH	1	•	·· · · ·			
		COMMO	IN/RCVR04	/DELT, ED(8) . GQG'	[(8,8),H(5,8),IC	DUNT, SIG	SMA						
	.,	·· COMMO	N/RCVR05	/NOLOE, NO	KLMN•NO	DAC, GAMAE	S(5),RO	IAG(5),P	PHDIAG((8)				,	
		CONHO	N/RCVRO6	/PPDIAG(8	TAMRet	5,51,PHI	(5,5),P	A(8,8),L	LAMDA(5	5 }		#			
20		CONKO	N/RCVR07	/T(130),V	(130)					•		• •			
		CONNO	N/RCVRO8	/XSLOE(8)	ESLOE	(8),ES(8)	1	•					•		
		• - СОННО	N/RCVR09	/BRCVR, BE	POCRI	r∍CC	-	•	•	\-		•			
		COMMO	N/RCVR10	/XS1(8),>	(8) 2)										
		CONHO	N/MLS000	/ALFA, THE	, THEOD!	.ALFAR,1	THR . THR D	OT, B, WSC	C -					•	
25		COMMO	N/MLSOOL	/CSNRT, CS	NRF, DS	IRDB, RHO,	BETA, FS	CALGHAX							
-		соммо	N/MLS002	/DCSNR, CS	NR. LG. 1	FPKT.TPKF	•			~			•		
		COMMO	N/MLS003	/FL10AE(4	,2),FL	LO(4),DEL	.TAT(2),	X0(8,21,	Y0(4,2	2)					
		сожно	N/MLS004	/BHLS, BBB	MTIMES	, HSET, MC	RE			•			-	•	
), THESER (•	
. 30 .				RS(6),IDA	SCILSO	,IDENTS	6),EEST	(13), TTC	00(13),	YYMI(13)			•, •	
			ISION YYK												
			ISION TSE			• •		·- ·	•	•			• •		
		DIMEN	ISION EEM	EA(13,9),	EERMS (l3,9),EES	TD (13,9)							
				AN(9), EMS				•		F1 + +					
35				EEME(1),E	EMEA(1,	2)},(EEF	H(1),EE	RMS(1,2)) } ,					•	
			(1),EEST			,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			- 400					- ••	•
				HERR, ES (2											
				ALFA,X(1)						•					
				ALF RMSE,											
- 40				DEG/SEC ,				BHTHR RM		•	• •	-, , -			
				TRD RMSE,					ES ,						
			RMSE,8H			RHSE, 8H F									
				A/,SPACE/				DAPTV/.T	TRUE./						
'				HMLSSIMDA			2*0/	-				• • •			
45				OHMLSSIMO											
				HCROSSHP,		TI, THRMS	E(B),7H	RMSE(F),	7H	` ,		• •		,	
				PHLS2											
		*8H PF	IL 53 58H	THRHLD .	BH OPT	CHL .BH S	UBOPT ,	8H -3 DE	8 8HA	MAPTIV	•				
				UNTETHRD,	BHTETHE	RED,2H	*8H POP	T1 98H	POPTZ	,					
50	•		PT3 ··/								**				
				/, IRSIGN/		(RT/11/,T	SEPO/	75/.DTSE	EP/.25/	,FILEIN					
•	· · · · ·			DUT/.TRUE							***** * *	•			
	·			H ALFA			II≯6H AL	.FAR>6HTH	HETAR, 6	HTHROOT	·				
		~ C,6H	8 "5H"	"WSC (, 6HW	SCOOTY	., .,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		,						- '	
55		DATA	ANAME/BH	BETA ,	BHDEGRI	: LS / , YN/	ME/OHTH	ES ERR,8	3 HD E GR E	E\$ /					
				HTHETASEP								-			
		UATA	FUNCTN/7	HAZIMUTH#	THEFEAT	A1 + /									

208KOOT INE	CONTRL	73/172 1	S		FTN 4.6	5+452	05/18/79	13.52.38	PAGE	2
		**** **** *** *							•	•
, ,				, , , , , , , , , , , , , , , , , , , ,						
60	1 FORMA	T(1H)	. , , , , , , , , , , , , , , , , ,	600,700,800,90	0,1000,1100,	15001 12A				
		7 (9(/))	•							
		T (1H1)								
		(21)27						4 41	'	
	C*******	********	********	*********	*******	******				
	Ċ									
	100 CONTI	NUE								
(C THIS IDEN	TIFIES THE	SCENARIO AN	D REINITIALIZE	S. AS NECESS	SARY. "	•	- •		
(CTHE FOLLOW	ING RECEIV	ER PARAMETER	S						
			FSC, BETA, JH	BHLS'		*** *** *** ***	, (/ · · · · · · · · · · · · · · · · · · ·		-
.70		IRST) GO T	0 155							
•		.TRUE.	• -	,	• •					
		TTRUE.		•			•			
		I≞JOBNAHE(I)		,					
7611	ISIN=		*** * * * * * * * *	the team of mosts						
19	. IMOD=									
		(7,110)	ve Turéen	CCENIARTOIL T		** *				
			VS. THESEP							
) NSTART=0 "				,			
80		OT.FILEIN)								
			PE15,DATIN)		- 4 , ,					
			L INTIO(6HIX	(AT) - TY - 1 - 1)						
	IF(IX	NE.O) STO	Pringut file	ATTACH NOT SA	TISEACTORYA					
	WRITE	(7,120) (0	ATIN(I), I=1,	21	1201 40 70 ((1)		_			
85	120 - FORMA	TIZ3H THIS	READS INPUT	FILE , 2A10/) .					• ••	
	122 CALL	LOGIO(6HFI	LOUT, FILOUT,	0)						
	~ CALL	INTIO(6HNS	TART, NSTART,	100;0)*******		~ 10 10,000 / 000			,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
		=NSTART								
			STOP, NSTOP, 1		·				• • • • •	
90			THRD,TETHRD,	0)						
		CVR.EQ.1)							•	
******			APTV, ADAPTV	0)					·	
•	125 ~~ CONTI			, , , ,						
· 05		THRD) ITET								
, 9 9	IRSIG	APTV) GO TI	0 135							
	- IADAP			,	, . ,,					
	135 CONTI									
		5 I=2)6	4m ×4 + 4	- terminal addression on their existences					m n- r	
100		3*(1-1)+10		ı						
1 F 1 7 FHFH		S(1)=IDASC					•			
	145 CONTI								•	
• • • • • · ·	ENCO	E(8,150,ID	ENTS(1)) IDA	SCI(ISIM), IHOD		• •		• •		•
		\T(A7,11)								
105		(7,152) I							•	
		T (1H ,611					·			
		[(7,153) I		FWOAD T +	•					
		(8A (HE) TA								
110			GMAX, LGMAX, 1							
110		INTID(6H	KM,KH,115,					,	v 1	
-,			TSEPO, TSEPO,							
			DTSEP, DTSEP,	V/	,					
		RT≃MINO(KM, 54 I≈1,LGHA								

SUBRE	DUTINE CONT	RL 73/172 TS FTN 4.6+452. 05/18/79 13.52.38 PAGE 3
115	154	TSEP(I) =TSEP0+DTSEP*(I-1)
		KMNET-KM-KSTART+1
		FSCMIN=1./(DELTAT(IAE)*KMNET)
		NRUN=NSTART-1
		DSNROB=20.
120		RHO*0.5
		BETA=45.
	· · · · · · · ·	IFS=1
		BHLS=1.
115		BRCWR=1.
125	155	CONTINUE
		NRUN+NRUN+1
*** ***		WRITE(7,11)
		CALL INTIO(6H NRUN, NRUN, 1, 1)
130		CALL REALIG(6HDSNROB,DSNRDB,0)
		CALL REALID(6H RHO,RHO,O)
		CALL REALID(6H BETA, BETA,0)
		CALL INTIG(6H IFS, IFS, 100,0)
		CALL REALID(6H BHLS, BHLS, 0)
135		CALL REALID(6H BRCVR, BRCVR, 0)
		6070 167
	158	CONTINUE
		READ(15,160) NRUN, DSNRDB, RHO, BETA, IFS, BHLS, BRCVR
	140	IF(EDF(15))170,165
170	165	FORMAT(15,3610.3,5X,15,2610.3)
		IF (NRUN. GE.NSTOP) MORE -FALSE.
	201	FSC=IFS*FSCHIN
		XD(5, IAE) = XD(2, IAE) - TSEP(1)
145		XO(3, IAE) = 0.
	(XO(6, IAE) = 0
		RETURN
	170	STOPHEDF REACHED ON INPUT FILEHOUS THE THEORY THE TOTAL
	C	· · · · · · · · · · · · · · · · · · ·
- 150 7	C ++++	**************
		ADJECTION OF THE PROPERTY OF T
		-CONTINUE
	U 1H1	S OUTPUTS BASIC SINULATION DATA OF INTEREST, SUCH AS ANGLE FUNCTION, INITIAL STATE, ETC.
155	CINE	WRITE(7,210) NRUN,DSNROB;RHO,BETA,IFS,BMLS,BRCVR
	21 0	FORMAT(5HONRUN, 12X, 6HOSNROB, 16X, 3HRHO, 16X, 4HBETA, 16X, 4HIFSC, 16X,
		*4HBHLS,15X,5HBRCVR/1H0,14,3(10X,G10.3),12X,15,3X,
		*2(10X,G10.3))
		IFI.NOT.FILOUT) GOTO 245
··160		"IF(NRUN.LE.9) ENCODE(10,220,DOUT)"IDNRS,1HU,IHOD,1HO,NRUN '''' '' " " " " " " " " " " " " " " "
	220	FORMAT(611,A1,11,A1,11)
		"IF (NRUN.GE.10) ENCODE (10,230,DOUT)" IDNRS,IHU,IHOD,NRUN"
	230	FORMAT(611,A1,I1,I2)
		IX=IREQST(6LTAPE17,3L*PF)
165		IF(IX-NE-0) CALL INTIDIGHIX(RQ),IX-11,1)
• •		IF(IX-NE-0) STOP#DUTPUT FILE REQUEST NOT SATISFACTORY#
		WRITE(7,240) (DATOUT(1),1=1,2) FORMAT(25HOTHIS WRITES DUTPUT FILE",2A10)
	245	CALL DATE(TODAY)
. 170	674	WRITE (7,250) FUNCTN (IAE), IAE
	250	FORMAT (1HO, AT, 15H FUNCTION (IAE=, 11, 1H))

SUBROUTINE	CONTRL	73/172	75	•	FTN 4.6+452	05/18/79	13.52.38	PAGE	4
	260 FORHAT WRITE((15H0I) 7,270)	((I,X(I)),I=1,; NITIAL STATE:// IDENTS(2)		,613.6))	A			. ,
175 -	270 FORHAT RETURN	(1H0,A7)						
	C********	*****	· ************	******	*****	***			•
180	CAND REINITI CIR (NEGATE	IFIES T	AS NECESSARY, NDAC,NOKLMN,NOL	THE FOLLOWING R		Audite base of a state.	# 1 14 5 - 120 yearnings in spring street designs from		
185	C C NEGATE IR		E FOLLOWING FOR	NONADAPTIVE RE	CEIVER				
	RETURN C C**********************************		*****	******			and high the deposited desired. Including the		•
•	Č 400 CONTIN C THIS DUTPU	IUE ITS BASI	C RECEIVER DATA		,		70 1 70 761 7		•
	410 FDRHAT	A (1H0) آ 4	8,4HRCVR/1H0,A8 H,NS=,I1,1H))	•éHDÉZIGN/2H (i	R=, I2,4H, NG=, I1,		4 4m / m 4 50 m .		
200		(1H0, A8	(IDENTS(I),I=5, /1H0,A7/)	0)				-	
	C********	******	******	*****	*******	***			
- w	C 500 CONTIN	 lue	ing the second		** *	, , ,	* 2 F	•	
205	C THIS SETS-	-UP THE	MSET-LOOP				, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	,	
	YYMI()) I=1,LG)=1.E32	2						•
210	510 TYYMA() RETURN		~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~	, , , , , , , , , , , , , , , , , , ,					
	.c	*****	*****	******	******	****			
215	600 CONTIN C THIS SETS- RETURN	-UP THE	LG-LOOP FOR THE	(MSET)-TH' SER	ES OF SETS				
* * * * * * * * * * * * * * * * * * *	C	*****	********	******	- ************************************	**** ****	,		
220			K-LOOP FOR THE	(LG)-TH SET DF	KH SCANS	•	-		
مس سند بر و	X(7)=	XO(7,1AE AUSS(1.0) """ · " · " · " · " · " · " · " · " ·		•				
225	705 FORMA	(7,705) T(1H1,4X		}	5X,5HX(5)=,G13.6/)			•	
	CALL	INTIO(6H	KM,KM,1,1}	•					

	SUBROUTINE CONT	RL' 73/172 TS ' " FŢN 4.6+452 " 05/18/79 13.52.38 PAGE 5
		e territorio de la
		WRITE(7,710) (TITLE1(I),I=1,NS)
230	. 110	FORMATICHO K,4X,5HCSNRT,4X,5HQTY ',9(3X,46,2X))
		DO 712 I=1,NS
	712	EMEAN(I)*O. The second of the
- ·		LASTCI=O
235		TODINT-O
	MIAN NY MA T	DO 730 IPA=1,NS
		DO 720 JPA=1,NS
	****** * * **	DO 720 JPA=1,NS PA(IPA,JPA)=0
	720	
240	730	CONTINUE
		RETURN
•	C :	*********
	C++++	*************
2/5		
245		CONTINUE
	CINI	S INITIALIZES THE K-TH SCAN
		RETURN
	c	na in the second
** 250	· ~= C*+++	*********
	Č	·
	900	CONTINUE
	C THI	S SAVES/PREPROCESSES DATA FROM THE K-TH SCAN
-		IF(ICOUNT.NE.LASTCT) SEP#ABORT
255		DO 905 I=1,NS
	905 -	m ES(I)=X(I)-XS(I)
		IF(NS.GE.7) ES(7)=ABS(X(7))=ABS(XS(7))
		"IF(NS.GE.8) ES(B)=ABS(X(8))-ABS(XS(8))
260		BETTA=(180./PI)*X(7)
200		COLBETHERR IF (IRCVR .NE. 1) COLBESQRT(PPDIAG(2))
**** * **		THE ADDRESS OF THE ALLER ADDRESS OF THE ALLER AND ALLER
		IF (IRCVR =EQ= 1) CALL DELTRI(COLB)THERR)FLO) IF((NRUN=EQ=NSTART=AND=LG=EQ=1)=OR=(K=EQ=KH)) GOTO 906 =GO TO 950
		- GO TO 950
265		WRITE(7,910) K,CSNRT,(X(I),I=1,NS)
•		-FORHAT(3H0 ,13,2x,G10,3,5H X=',2x,9(G10,3,1x))
		WRITE(7,920) (XS(I), I=1,NS)
	920	" FORHAT(18X,5H XS= ,2X,9(G10.3,1X)): = "
		WRITE(7,930) (ES(I),I=1,NS)
. ~ 270	930	FORHAT(18X,5H ES= ,2X,9(G10,3,1X))
		IF(IRCVR.EQ.1) WRITE(7,940) CDL8
		FORHAT(8X,15HUNFILT. ES(2)= ,13X,G10.3)
	950	XDATUH(K)=BETTA
476		THESER(K)=THERR
275		LASTCT=ICOUNT TIF(K.LT.KSIART) RETURN """""" IN THE PROPERTY OF THE PROPERTY O
		DO 960 I*1,NS
	960	EMS(I)*EMS(I)*ES(I)**2
280		RETURN
	С	
	C+***	*******************************
	C	
		CONTINUE
285	C THI	S SAVES/PROCESSES/OUTPUTS DATA FROM THE (LG)-TH SET OF KM SCANS

SUBROUT	INE CONTI	RL '73/172- TS"	* *	· - FT	N 4.6+452	05/18/79	13.52.38	PAGE	6
	m., . 100								
		DG 1005 I=1,NS EMEAN(1)=EMEAN(1)/KMNE EMS(1)=EMS(1)/KMNET	:т _		• •		en p y K		
290	1005	ERMS(I)=SQRT(EMS(I)) ESD(I)=SQRT(EMS(I)=EME	EAN(I)*+2)			4 - 4 4 W M P4	ha makali bi iyo iyosi ila aa aasa bi a m		
	1005	CONTINUE							
•	• •	TCDUNT=100.*XW/KM WRITE(7,1009)	, ., .,					••	
295	1009	FORMAT(3(/)) WRITE(7,1010)KMNET	14 9 4 4				***	•	
	1010	FORMAT(5X,26HERROR SA)		(,13,9H SA	HPLES))				-
	1015	FORMAT(5X,31HTHRESHOLD		ERROR)}	•		•••		
_ 300	1020	FORMAT(1HO, 20X, 4HQTY)	9 (3X, A6, 2X)) -					•	
	1030	WRITE(7,1030)(EHEAN(I) FORMAT(1H0,16X, BHEMEAN	$V = \frac{1}{2}9(G10.3,1X)$,					•
1305 -	1040	FORMAT(18X,7HERMS = ,9	9(G10.3,1X))		•				
	1050	WRITE(7,1050)(ESD(1),1 FORMAT(19X,6HESD = ,9	(G10.3,1X}) '	* **	•	٠			
	1060	.IF(IRCVR.EQ.1)WRITE(7 FORMAT(//1H ,4X,F7.2;	22H% OF SCANS AR					•	
310	1070	IF (IRCVR.NE.1) WRITE(7) FORMAT(5(/),4X,35H ON			T WAS/26X				
	_	C9(G10.3,1X)) DO 1071 I=1,NS					' , 		
*** 315 ** *	·	EEHEA(LG,I)=EHEAN(I) EERHS(LG,I)=ERHS(I)		· · ·	*** ** *** ***	, 4, 131 404444444			
	1071	EESTD(LG,I)=ESD(I) DO 1072 I+1,KM	* ** ***				· ** - *		
- 1	1072	YYMI(LG) = AMINI(THESER) YYMA(LG) = AMAXI(THESER)			-				
320		TTCO(LG) * TCOUNT IF (LG.NE.1) RETURN' "				he a green th			
,		YHIN=YHAX=0. WRITE(7311)'							
325		CALL PLOTR (XDATUM, THE	SER,KM,XNAME,YNA	ME, YMIN, YMA	(0 e X		-		
	C	*******							
	Ċ	CONTÎNUE '				· · · · ·			
330	C THI	S SAVES/PROCESSES/OUTPE				, , ,			
	~ CLGMA	X SETS OF KM SCANS WRITE(7,11)	. ,		•	,			
	.,	CALL INTIO(6H NRUN,NI WRITE(7,1110) 6HTHESEI				,		•	
335	1110	FORMAT(1H0,10X,3HQTY WRITE(7,1120)TSEP(1),			4 7 3	- '			
-	1120	FORMAT(1HO, 7X, 7HEMEA) DD 1130 J=2, LGHAX			•	* * *	•		
340	1130		(EEMEA(J,I);I=]	LyNS) " " ""				- c	
	1140	FORMAT(1HO) 8X, 6HERMS	,9(G10.3,1X))	4	•	•			

JOHNOOT INE CONTR	12/1/2 12	1111 1001122	43720777 23472430 TROE	•
Market of the supplementary below of the defining to		** ** ** ** ** ** **		
1150	WRITE(7,1161) TSEP(J),(EERHS(J,I),I=	1,NS)	•	
	WRITE (7,1160) TSEP(1), (EESTD(1,1), I=1			
345 1160	FDRMAT(1HO, 8X,6HESTD: ,9(G10.3,1X))			
	DO 1165 J=2, LGMAX		*	
	WRITE(7,1161) TSEP(J),(EESTD(J,I),I=	1,NS)		
	FORMAT(15X,9(G10,3,1X))		.,	
	IF (.NOT.FILOUT) GOTO 1199			
350	WRITE(7,11)			
	WRITE(7,1170) (DATOUT(I),I=1,2)			
	FORMAT(13H OUTPUT FILE , 2A10, 1H: /)	() .)		
•	WRITE(7,1172) DOUT,DELT,HTIMES,LGMAX FORMAT(1H',A10,8X,G13.6,5X,3(5X,13,1	,KM,TODAY,JBNAH	1	
1172	FORMAT(1H', A10, 8X, G13.6, 5X, 3(5X, I3, 1	OX},A10,8X,A10/)	,	5 75 22 25 15 1
355	WRITE(7,1174) IDENTS, KSTART			
··· · · · · 1174	FORMAT(1H ,6(1X,A8,9X),6X,I3/)	•	A 100 T 4	•
	WRITE(7,1176) NRUN,DSNRDB,RHD,BETA,F	SC, BHLS, BRCVR		
	FORMAT(1H ,5X,12,6X,6(5X,G13.6)/)	1 2 2 20 11 11 1	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
	DD 1175 LGN=1, LGMAX			
3601175	WRITE(7,1182) EEHE(LGN), EERH(LGN), EE	ST(LGN),TTCO(LGN),YYMI(LGN),	1	
_ *	YYMA(LGN);TSEP(LGN);LGN	•	•	
	FORMAT(1H +7(G13+6+5X)+15) '	· · · · · · · · · · · · · · · · · · ·		
	WRITE(17) DOUT, DELT, MTIMES, LGMAX, KM,	TODAY, JBNAH		
12, 0121,440,400, 000, 000, 000, 000, 000, 000,	WRITE(17) IDENTS, KSTART			
365	WRITE(17) NRUN, DSNROB, RHO, BETA, FSC, B DO 1190 EGN=1, LGMAX "''	MLS, BRCVR		
	DO 1190 LGN=1,LGMAX "''			
1190	WRITE(17) EEHE(LGN), EERH(LGN), EEST(L	GN),TTCD(LGN),YYMI(LGN),		
•••••	I IUV (FOU) > 1 25 L FOU) > FOU		,	
	IX=IATTACH(6LTAPE20,DATOUT)			
	IF(IX.NE.O) GO TO 1195	******	,,, = ==, ==, ,	
	READ(20) DUM, DUM, IDUM, IDUM, IDUM, DUM,	IDUN		
	CALL RETURN(6LTAPE20)			
	IX-ICATALO(6LTAPEL7, DATOUT, 2LPH, 8RHI	GHFILL, ZLKP, 303)	•	
	GO TO 1196 .	-1	4 P 40 P 40 P 10 P 10 P 10 P 10	
	CALL RETURN(6LTAPE20)		,	,
	REWIND 17 IX-ICATALO(6LTAPE17,DATOUT,2LXR,8RHI	CHCTIL SLDD SARY """" '""		
	IF(IX.NE.O) CALL INTIO(6HIX(CA),IX,1			
	IF(IX.NE.O) STOP # OUTPUT FILE CATALOG			
	CALL RETURN(6LTAPE17)	HOT SKILDI ACTORIE		
	WRITE (7,1198) (DATOUT(1),1=1,2)			
	FORMAT(13HOOUTPUT FILE ,2A10,33H IS		an s	
		*** ***	The same areas on the same as a same	
	DO 1103 I=1,NS	,	•	
	FACTOR=1.		* * * * * * * * * * * * * * * * * * * *	
	IF(I.EQ.7) FACTOR=180./PI			
	IF(I.EQ.8) FACTOR=.5/PI "			
	IF(I.EQ.9) FACTOR=.5/PI			
	YHIN=0.		provening and the second security of the second sec	
- • •	YMAX=0.	•		
	DO 1101 LG1=1, LGMAX		* *	
	EEHE(LG1)-EERMS(LG1, I)+FACTOR			
	YNAME1(1)=YNAM1(1,1)		•	
	YNAME1(2)=YNAM1(2,1)			
	K1-HOD(I,2)	and the same and t	·	•
	IF (K1.Eq.1) WRITE(7,11)			
	IF(K1.Eq.1) CALL INTIO(6H -NRUN, NRUN	-1-1)		
	IF(K1.Eq.0) WRITE(7,10)		,	

	SUBROUTI	NE CONTRL	73/172	TS			FTN 4.6+45	2 .	05/18/79	13.52.38	PAGE	8
				. ,		مأت سم	P / 41 P P 4 P 4 P 4 P 4 P 4 P 4 P 4 P 4 P					
400		CALL	PLOTŔ(TS	EP, EEME,	LGHAX,XNA	ME1, YNAME1, Y	MIN,YMAX,O)					
m-		1103 CONTI		7**	• •	•	•				-, •	•
		RETUR C	и -		•							
	•	C********	*******	******	*******	******	*******	******				
- 405		" C	* · ·		,		• •	•		***********		
e toer		1200 CONTI C THIS EFFE RETUR	cts clos	URE OF T	HE"SIMULA	TION RUN ""						
		, C , , , ,	· '•			<u>.</u>				* 1 / 1 / 1 / 1		•
410		C	*******	******	*****	*****	*******	*******				
_		END										
45000	B CH STOR			7 SECOND	\$		` -	•	,			

SUBROUTINE	CONTRL 7	73/172 TS		•	FTN 4.6+452	05/17	/79 17.2	5.54	PAGE	1
		UTINE CONTRL(1 V as as 100 as 1					-
	c	•••							•	
	C THIS CON	DUCTS THE HLS	SIMULATION THRO	DUGH A						
		OF LOE PERFOR		• •	74 7	**/ 1			•	•
5			IGATES THE ERRO	DR PERFORMAN	ICE					
	C									- 4, 222
	REAL	LAMDA								
	REAL	E(2), TE(2), MS	SE ** * * * * * * * * * * * * * * * * *		•	'				•
	LDGIO	AL NOKEMN, NOL	JE, NOAC, KALHAN, I	LOE, TETHRO, P	IORE, NFIRST, ADA	VPTV				
10		ER FUNCTH(2)		•		"			-	_
	REAL	XNA(2), YNA(2)		_						
	- """" COMMO	M/IODATA/ISIM,	IPMLS, IRCVR, IAC	DAP,ITETHR,I	POPT					
	Cammo	N/ŖCVROO/THAM/	XX,THAMIN,TS,TR,	· DMEGA • TF						
			l,NGMAX,DELBL,N€		•	•				
15			X, OTHO, TORO, BO							
			(8,8);FL25(4),F							
			ED(8), GQGT(8,8)							
			, NOK LMN, NOAC, GA				1			
			IG(8), RMAT(5,5);	, PHI (5, 51, PA	(8,8) LAMDA (5)		.)			
. 20		IN/RCVR07/T(130			-					
			(8),ESLOE(8),E	2 (8)						
			R, BB, POCRIT, CC	'			•			
		N/RCVR10/X51(8			T 5 1155 '	\1 P -				
•			THE, THEDOT, ALF,							
25			CSNRF, DSNRDB, F		LUMAX					
			R,CSNR,LG,TPKT,1							
			4E(4,2),FL10(4),			' -				
			,888,MTIMES,MSE1		00111115 101 4	/r.a.				
			(20) BETAE (20)	POCKISSITA	i porrítaitoiix	· F · O /				
30		NSION DMAT(5):	,,),NAME5(11),NAME	F0/E1						
			IDASCI(24), IDEN							
			TE(50), PABORT(10		11				•	
			((1)),(ISIM,IDNF		;'	-		-		
35			ACE/1H /, ADAPTV		,				,	
			SMP, THRMSE(T), 71		MSECEL. THACOST	' ' NT				
	*2*7H		SE, THGENERAL, 81							
			D 8H OPTIML .			APTIV . '				
			RO,8HTETHERED,2			*				
40		PT3 /			1. 70., 10., 10.	·				
.5			S1GN/1/,KMNET/20	07						
		FUNCTN/7HAZIM					~ . ~		• •	
		TSEPMN/-0.50								
			G, 6H EZAVG, 6H E	EIMIN» 6H EZM	IN.			•		
45			6H EIRMS, 6H E2F							
. ,		RMSE/ '		•		•	- '*			•
	DATA	NAMES/3HAVG.	BHAVG, 3HMIN, 3HMI	IN, SHKAX, SHR	IAX, 3HRMS, 3HRMS	5,				
		/G,3HAVG,3HAVG		F 4 + 1-2		At and the sales of the		***************************************		
			6,6H TEMIN,6H TE	EMAK,6H TERM	IS 2H /					
-50		BETMIN/O./				- •				
		XNA/bH SCAN	,8H K /							
		"YNA/8H" X2-XS2								
	C	· · · 	·	•						
	TGO TO	11007200,300	400,500,600,700	0,800,900,10	00,1100,1200);	ISW		•		_
55	1 FORMA	VT(1H)								•
		T (9(/)')''	******* * ***** **		•	•	-	•		
	11 FORM	AT (1H1)								

CTLOE Page 1 of 7

		•						
	•	C + + + +	*******				•	
60		Č				********		
	•	160	CONTINUE				•	
		C THI	S IDENTIFICS THE SCENAR	RIO AND REINITIALIZES	AS NECESS	ARY)		
		CINE	FULLUWING RECEIVER PARA	AMETERS	•	,		-,
		CSIGM	A, IAE, DSNROB, RHO, FSC, BE	ETA, JM, BMLS				
65			MORE=.FALSE. JBNAN*JOBNAME(I)					
			ISIM=0	•				
			1MBO = 3			•		
			WRITE (7,110)					
70		110		RMANCE STUDY)				
			CALL INTID (6H KMNET, F					
		_	DělBL=.01					
	- , ,- ,,	_	LGMAX=10			1		
			MTIMES=20		72.7.			
15			TETHROFITRUE. " " " " " " " " " " " " " " " " " " "					
			NOKLMN=.TRUE.				No access po and and	
			CALL REALID (6HDSNRDB)	DSNEDR.OL				
				RHO, 0)		•	M P-8 36.	
80			CALL REALID (6HTSEPM)					
	• • •		CALL REALIO (6H DISE		•	•	from the common promote name (acc.)	
			CALL INTIO (6H NTSEP,					
• -		-	" CALL REALIG(6HBETMIN,		/		••• •• •	
	or s		CALL INTIG(6HNOBSEP,)	TTIMES, 20, 0)				
65			DBETAE = 360./MTIMES				,,,	
		120	DØ 120 I=1, LGMAX TSEP(1)=TSEPMN+(1-1)*	kntsco "" " "" " " " " " " " " " " " " " " "		- +		
		* = 0	DU 126 I*1, MTIMES	OISEF				
•	•	126	BETAE(I) = BETMIN+(I-1)*DBETAE '			•	
90			XO(3, IAE) = 0;	• • • • • • • • • • • • • • • • • • • •				
	• ••	•	" XO(5,IAE)=XO(2,IAE)-1	TSEPMN ' T T T T T T T T T T T T T T T T T T		* 1		
			XO(6, IAE) = 0.					
			BETA=8ETMIN					
95	•		FSC=C. CALL LOGIO(6HTETHRD, TE	TUPO.AL 1 TIL			•	
••			IF(IRCVR.EQ.1) GO TO 1					
-		4-	CALL LOGID (6H NOLDE, NO					
			CALL LOGIO (6HNOKLMN, NO					
• •	- ^ -		TIF (NOKLMN) KSTART=1				t florer marke on surrane art and a real of	• •
100			CALL LOGIO(6HADAPTV, AC	DAPTV.O)				
		125 ~						
_			KM=KSTART+KMNET-1					
			CALL INTIO (6HKSTART,	(START,1,1)				
1851			CALL INTIO (6H KM,⊬ "1F(TETHRD)"1TETHR±2	(M,1,1)				•
103			IF (ADAPTV) GO TO 135					
			1R51GN=41					
			IADAP=3					
		135	CONTINUE	T 1/4 SEP T SEP T-880 SERVICE T	•	•		
115			DO 145 I=2,6					
	•		IASC = 3 + (I-1) + IDNRS(I) +			,		•
		146 "	IDENTS(I) = IDASCI(IASC)	}				
		145	CONTINUE """	1) TOLOCTITCIES THAN		-		
			ENCODE(8,150, IDENTS(1)	II TOUSCILISTUISIUDD				

C45U2	UTINE CONTRL 73/172 TS FTN 4.6+452 05/17/79 17.25.54 PAGE 3
115	150 FORMAT(A7,11)
	WRITE (7,152) IDNRS, IMOD
	152 FORMAT (1H ,611,1X,11/) '
	WRITE (7,153) IDENTS
120	153 FORHAT (1H ,A8) RETURN
150	C
	C 4 + 3 + 4 + 4 + 4 + 4 + 4 + 4 + 4 + 4 +
	C ·
	200 CONTINUE
125	C THIS OUTPUTS BASIC SIMULATION DATA OF INTEREST, SUCH AS
	CALL DATE (TODAY) INTITAL STATES ELG.
- · · · · · · · · · · · · · · · · · · ·	WRITE (7,250) FUNCTN (IAE), IAE
	250 FURMAT (1H0,A7,15H FUNCTION (IAE=,I1,1H)) .
133	WRITE (7,260) ((1,X(1)),I*1,B)
	260 FORMAT (15HOINITIAL STATE://(3H X(,11,4H) = ,613.6))
	270 FORMAT(1HO, A7)
135	c ,
	C
	C THIS IDENTIFIES THE BASIC RECEIVER STRUCTURE (THRHLD, DPT, SUBOPT)
·- 146 ·····	CAND REINITIALIZES, AS NECESSARY, THE FOLLOWING ROVE DATA
	CIR (NEGATE ONLY), NOAC, NOKLHN, NOLDE, BRCVR, DELBL, TETHRO
	TITIT I ITIT MING(IRCVR, 2)
mas,	THE PROPERTY OF THE CAMERIAN IN THE PART I
145	TF(IRSIGN.LT.O) IR == IR
	in the control of the
	RETURN
	C 141.77 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -
150	【李春李本春水本半来来来来来来来来来来来来来来来来来来来来来来来来来来来来来来来来来来来
150	400 CONTINUE
•	C THIS DUTPUTS BASIC RECEIVER DATA OF INTEREST.
	WRITE(7,410) (IDENTS(I), I=3,4), IR, NG, NS
	410 FURMAT (1HG,AB,4HRCVR/1HG,AB,6HDESIGN/5H (IR*,IZ,4H,NG*,II)
155	* 4H,NS=,II,1H})
	WRITE(7,420)'(IOENTS(I),I=5,6) 420 FORMAT(1H0,A8/1H0,A7/)
	RETURN
	C .
160	· · · C + + + + + + + + + + + + + + + +
	C 500 ''CONTINUE'
	C THIS SETS-UP THE MSET-LOOP
	ICOUNT *0 TO THE TOTAL THE
165	DU 502 J=1,LGMAX
	BULL (11, J) = 0
	BULL(12, J) = +1.6322
	BULL(14, J) = 0.
170	BULK(15)]*[0,

	20880011	NE CU	NIRL 737	172 15			FT	N 4.6+452	05/17/7	9 17.25.54	PAGE	4
	• •	. •	BULK(17, J				* ***** * **				*** **	
•		•	BULK (18, J)=+1.E322		-			•		•	
175			8ULK(19,J BULK(20,J		'				•			
		_	_PABMAX(J)	1.E322								
			BULK(21, BULK(22,	J}=0.	, , ,							
	•		BULK(23,				••	•		384 ·	• •	
100),	14 E	BULK(24)		•				4-4			
		50	2 CONTINUE									
			CALL INTI WRITE(7,	O (6HMTIKES	, MTIMES, 1	(,1)	7H-12 MG					
185	;	- 510	FORMAI(1H	1,40X,21HLC	SE ERROR P	ERFORMANCE	/}		•			
	•	51	WRITE(7,	511) (TSEP((I),I×1,LG	SMAX) (X,F8.5,2X)						
_			WRITE(7)	512)			,					
190	1	512	FORMAT(1H RETURN	O,5HBETA:)	•• •	/ / / / / / / / / / / / / / / / / /					• •	
	•	Ç	• •							ert va		
		C * 4	*******	*****	********* ` -	******	*****	*******	*****		•	
		600										
195		СТ	HIS SETS-UP	THE LG-LOOP AE(MSET)	FOR THE	(MSET)-TH	SERIES OF	SETS				
		•	XO(7, IAE)=PI*BETA/1	180.	٠. '						
			X(7) = X	0 (7,1AE) et.8).eo.a.	woite/2	7,511)(TSEP	(11.7-1.1	CHAVE				
200)		RETURN			,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		GHAKI				
		C C**	******	******	*****	******	******					
		· č	•				•		*****	• ••	•	
205		700 C T	CONTINUE HIS SETS-UP	THE K-100P	EDR THE (LG)-TH SET	пе ки сс	244				
			THESEP=T	SEP(LG)		/ > / >						
			X(5) # X DUM=GAUS	(2)-THESEP S (1 ₄ G)								
210		•	. LASTCT=0						- , ,		**	
210	,		ICUUNT=0 FL10(4)=			·- ·	•	-				
		<u>.</u> .	THETAV=0.		plane or any happenson or		ance water total	p = 1-07, 2 - 1 = 1				
			THETMN=+1 THETMX=-1							•		
215			THERMS=G. Elavg=0.		-1		•					
•	-		" E2AVG=0.		** * ** ***			-				
			E1MIN=+1.				-1					
220	ı		E1MAX=-1.									
			EZMAX=-1. EIRMS=0.			•						
			E2RMS 0.		1.0							
. 225			MSE=0. LASTCT=0		,		** ** **					
	_		DD 705 1*	1,8								
	, ,	705	DO 705 J= PA(I,J)=U		••							
			•	-								

SUBROU	TINE CONTRL 73/172 TS	* **		FTN 4.6+452	05/17/79 17.25.54	PAGE	5
	RETURN		,	11 MPTP 4 T 1 T T	graph on the Andrews of the Andrews		
230	C , ,	•				•	
200	C+++++++++++++++++++++++	********	******	******	: ★ ★ [*]		
	, c .	· ·	• •	•		•	
	860 CONTINUE						
	C THIS INTITALIZES THE K-T	TH'SCAN					
235	DO 810 I=1,5			4, MA 14 MAIN 1	1 m 1 m 1 m 1 m 1 m 1 m 1 m 1 m 1 m 1 m		
	810 RDIAG(1)=1. ^						
	IF(TETHED) RETURN RETURN			 ,			
	C						
240		**********	********	***********	***		
	c						
	GOS CONTINUE	•		•	•		
	C THIS SAVES/PREPROCESSES	DATA FROM THE	K-TH SCAN				
	C					•	
245	C FOLG SHOULD BE IN RO	VR					
	C				Į.		
	X5(1)*A85(X5(1))				***		
	" XS(4) *ABS(XS(4)) 1F(1COUNT.NE.LASTCT)	CEDWADOOT					
. 250	THERR=X(2)-XS(2)	361-X00V1					
-50	IF (IRCVR.EQ.1) CALL	DELTRI (THERR	.THERR. EL 10	3	•		
	LASTCT-ICOUNT		2				
	IF (K.LT.KSTART) RETU	JRN					
	TE(1)=X(1)-XS(1)						
255	TE(2)=THERR						
	THETAV=THETAV+TE(2)						
	THETMN=AMIN1(THETMN)						
	THETMX=AMAX1(THETMX,				•		
- 260	THERMS*THERMS+(TE(2)						
200	IF((RDIAG(1).GT.1.E-		G(2).GT.1.E	-2931) GOTO 910			
	CALL MATOUT (6H PHI					-	•
	CALL MATOUT (6HRMAT					•	
	" CALL MATNUL (5) NG, NG			MAT,1)		"	•
265	CALL MATOUT (6HR*PH)		,1)				
-	"STOP *BAD MATRIX PHI	[pl		- ,	111 12 17 / 11		
	910 CONTINUE						
	SIG1=SQRT(RDIAG(1)) SIG2=SQRT(RDIAG(2))						
-270	E(1)=TE(1)/SIG1						
-,0	E(2) *TE(2)/SIG2						
	Elavg=Elavg+E(1)		****		ATT - 1		
	EZAVG=EZAVG+E(Z)			'			
	E1MIN=AMIN1(E(1), E1	MIN)					•
275	E2MIN=AMIN1(E(2),E2						
	EIMAX=AMAX1(E(1),E]						
	EZMAX=AMAX1(E(2), EZ					•	
	E20MS=E1RMS+(E(1)**		,				
280	#*(E2RMS+(E(2)** * * * DO 920'I=1;2 * *						
200	DO 926 J=1,2						
	920 - NSE*MSE+TE(I)*TE(J)	*PHI(I, J)					
	RETURN						
-	C ************************************			u.			
285	C**************	*********	*******	**********	**		
					h Jim h	•	

	SUBROUTIN	E CUNTI	RL 73	/172 T\$	•				FTN 4	4.6+452	2	05/17/79	17.25.54	PAGE	6
				~~ ~~		•	• • •	• • • •	: - :		** *				
		C		_				\ #							
			CONTINUE												
		Ç THI:	S SAVES/P	ROCESSES/	OUTPUTS DA	ATA FRO	3H THE	(LG)-T	H_SET	OF KM	SCANS				
			8066(1,6	S)=THETAV	/KMNET '				-						
290	0		BULL(Z,L	G) = THETMN	i									,	
			8ULL(3,L	G)=THETMX	, '			*	•		****				
			BULL(4.L	G) = SORT(T	HERMS/KMNE	T)									
**					11, LG)+BUL		; ·		• • • •			· · ·	• ···· • · · · · · · · · · · · · · · ·		
					(BULL(12,										
29:	s				(8ULL(13)L					•				"	-
	•														
					14, LG)+(TA		ruuž 11				•		- ~	· · · · ·	
					1COUNT 1/KM										
		_			PABMAX (LG)	PABUI	KŢ(LG):	Į.	_						
				R.EQ.1) R											
3)(ט		BULK(1,L	G)×Elavg/	KMNET										
		• .	BULK(2,L	Gl=E2AVG/	'KMNET '		• •			•				•	
			BULK(3,	LG)#E1MIN	l		•								
		•	BULK (4)	LG)=E2MIN	i			•	•	• • •	•	•		•	
				LG)=E1MAX											
30	5 ⁻			LG)=E2MAX		·-		•			•				
					1RMS/KMNET	۲١									
	•				2RKS/KMNET							***			
					(8ULK(7,L		0111110	101442	1/21						
	- ***								1121_						
314	۸				(BULK (7, L (K (O) L G	1 2							
21.					MSE/KMNET							24 4 TT			
					((15,LG)+B(
					((16, LG)+Bl			_			4				
			BULK(17	∍LGI=AMIN	11 (BULK (17,	, LG) , BI	ULK(3):	LG)) ~		•					
			BULK (18	∍LG)=AHIN	{1(BULK(18,	, LG) , BI	ULK(4,	LG)}							
31.	5 " '` `		BULK(19	,LG)=AMAX	(1(BULK(19,	LG),B	ULK (5,1	LG)) ^	~						
			BULK (20	LG) = AM AX	(1 (BULK (20)	LG } . B	ULK (6.1	LG))							
					((21, LG)+B(• • • •	• • • •						
					((22, LG)+8L										
	· 	•			((23, LG)+BL						-			- 1	
3 2	0				LG)+Bl										
					((25, LG)+B)										•
			RETURN) L 0 } - D 0 C N	,		,								
	-	c	KCIOKII .				• 47								
		Ç 4 4 4 4										_			
32	Б .				,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			******	****	*****	******	т ,			
32	,	1100	COUTTHUE												
 .			CONTINUE						A						
					OUTPUTS 'DA	ATA PK	OW THE	(H2F1)	-1H 2	ERIES (DF				
		CLGMA	X SETS OF											_	
•				1101) BET	[A		1		•	• • •				•	
3 3	0	1101	FORMAT(1	HO, F7.2)											
-	7 •		00 1160	I=1.4"			pe 14m		•					-	
			WRITE(7)	11501 NAP	1E8(I),(BUI	LL{IøJ) = J=1 =	LGHAXI							
		1150			1H=, 10(1X									m	
			CONTINUE			,	• •								
33	5				RITE(7,1150	01 AUT	ARDOT.		7.15. 1	-1 -1 CM	A V 1 .				
	-			.E0.1) F		0.5 0.51%	N D UN 1 9	TADOKI		>	~ ^ 1				
						.4.1.64							· ·		
		3300	MATICAL	TT021 (B)	ULK (1, J), J	- エクレジバ	AAI								
• • •		1103	. FUKMA! (1	D 1 (X) (H	ElAVG=,10	(L X) G }	0.9711								
				1=2,11											
34	Ü .		WRITE(7) 1115) N	AMES(I),(BI	ULK(I)	1=1	, LGMAX)		_					
	•	1115	FORMAT	(1H 7/X)	46,1H=,10(1X,G10	:3))		-	•					

SUBRDUT	INE CONTRL	73/172 TS	•	-	FTN 4.6+452	05/17/79	17.25.54	PAGE	7
	RETU	 RN	* * * * *	eac toperat c	٠, ,,	• •		•	
	C						•		
3.4.5	C++++++++	********	*********	*******	******	***	,		
	C 1200 CON1	THIS						·	
		ECTS CLOSURE OF	THE SIMULATIO	N'RUN					144 444
,		220 I=1, LGMAX							
350''		(11,I)=BULL(11,		•		-		•	
		(14, I) = SQRT (BUL							
		RCVR.EQ.1) GOT K(15,1)=BULK(15							
		K(16,1) = BULK(16							
355		K(21,1)=SQRT(BU		S)					
- **		K(22,I)≠\$QRT(BU					, ,,,,,,	• •	
		K(23,I)=SQRT(BU K(24,I)=SQRT(BU				,			
		K(25,1)=30RT(8L						•	
360	1220 CON			T					
•		TE(7,1230)							
		MAT(1HO,9HWRT'E	SETAL/) T "	* ***	••			•	
		233 I=11,14 I-10"							
365		E(7,1234) NAMES	5(2*111).NAME8(111) + (BULL()	(J) J=1 = LGHAX)				
	1234 FORM	AT(1H ",3X,"A4, A6			2 - 1/2				•
	1233 CONT								
-				,6HZABGRT, (1	PABHAX(J),J=1,LGH	AX)	- ,		
370		IRCVR.EQ.1) GOT 1245 I×15,25 ''''	U 1246		. , ,				
310		I-14							
	WRI	TE (751240) NAME			J=1.LGMAX)	J4		m ()	
		MAT(1H ,3X,A4,A	16,1H=,10(1X,G1	.0.3))					
3 7 5	1245 CON' 1248 CONT								
313		TE(7,511)~(TSE	(I).I=1.LGMAX)	·				•	
		TE(7,1250)	(1),1 2,00,000					,	
	*** 1250 " FOR								
. 2001 # ##		RCVR.NE.1) WRIT			; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ;				
. 380	RETU:	AT(13H GQGT(I,]	() =)(13.0)((1	.X)G13.011			1		
	c ·						}		
	C+++++++	*****	*********	****	*****	***)		
385	END							•	
440008 CM STD	DACE HEED	7.674 SEC		e pair e si complement del dell'alle		7 80 8-0-1	,	•	
440000 CU 310	KAGE USEU	1.0014 3676	11102						

SUBROUTI	HE MLSS	UB 1 73/172 TS 1 PAGE 1
		to a company of the c
•		CORDOLITAIN MI COUR
		SUBROUTINE MLSSUB
	•	REAL LANDA
		LOGICAL NGKLMN, NOLOE, NOAC, KALMAN, LOE, TETHRO, HORE
_		CUMMON/RCVROO/THAMAX, THAMIN, TS, TR, DMEGA, TF
5		COMMON/RCVROI/NGMIN, NGMAX, DELBL, NGM, IR, IAE
		COMMON/RCVRO2/RHOMAX,DTHO,TORO,BO,WSCO,NSO(4),NGO(4)
		COMMON/RCVRO3/PI,F(8,0),FL25(4),FSAMP,K,KM,TETHRO,NG,NS,JM
		COMHOM/RCVRO4/DELT,ED(8),GQGT(8,8),H(5,8),ICDUNT,SIGHA
		COMMON/RCVF05/NGLDE,NOKLMN,NDAC,GAMAES(5),RDIAG(5),PMDIAG(8)
10	•	COMMON/RCVRO6/PPDIAG(8),RMAT(5,5),PH1(5,5),PA(8,8),LAMDA(5)
		COMMON/RCVR07/T(130),V(136)
	- ** ** * **	COMMON/RCVRO8/XSLOE(8), ESLOE(8), ES(8)
		COHHON/RCVRO9/BRCVR,BB,PDCRIT,CC
		COMMON/RCVR10/XS1(8),XS(8)
15		COMMON/HLSOOO/ALFA, THE, THEDOT, ALFAR, THR, THRDOT, B, WSC
•		COMMON/MLSU01/CSNRT, CSNRF, DSNRDB, RHO, BETA, FSC, LGMAX
		COMMON/HLSUOZ/OCSNR, CSNR, LG, TPKT, TPKF
		CGMMUN/MLS0U3/FL10AE(4,2),FL10(4),DELTAT(2),XD(8,2),YD(4,2)
		COMMON/MLSOO4/BMLS, BBB, MTIMES, MSET, MORE
20	C C	ERAL SIMULATION: OPTIMIZATION OF MLS RECEIVERS FOR
	C	MULIPATH ENVIRONMENTS
	C	
		DIMENSION X1(8), INDEX(2), Y(4), X(8)
		_EQUIVALENCE (THAMAX,Y(1));(ALFA,X(1))
	<u> </u>	
25	C F	ILG BEGINS EXECUTABLE STATEHENTS
	C	
		PI2=2.*PI
		\$ \$ 922 = \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$
	. C	and the second s
30	. C	FOLG INITIALIZES THE DIAGONAL OF F(8,8)
	С	
	9	DO 10 I=1;8
		F(1,I)=1.
,	16	CONTINUE
35		CALL CONTRL(1)
		SSQ2=SIGHA*SQRT(2.)
	C	
	С	TOULDWING TOOMPLETES INITIALIZATION AND COMPUTES SECONDARY
	C	PARAMETERS.
40	c	
	-	DO 15 I=1,4
		FL10(1)*FL10AE(1,1AE)
	15	CONTINUE
		00 20 1=1,4
45		Y(1)=Y0(1, IAE)
	20 "	
	LU	OMEGA=-(THAMAX-THAMIN)/TS
		"SECPD=11/OMEGA"
		TF=TS+TR-2.*THAMIN*SECPD
50 ··· ·	٠	TF-13TIR-Ze-tinaniut-seeru
50	,	C ADE CONSTANT DADARGEOGO NECO DV D
	C FD	G ARE CONSTANT PARAMETERS USED BY P
	C	200 0 4 400 0
		BBB = 2.4/8MLS
		DUM=GAUSS(1.0)
55	_	ALPHA=10.**(DSNRDB/20.)
	•	XO(1,IAE)=ALPHA
		ALPHAR=RHO+ALPHA .

7
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Ü

	PROGRAM	MLSSI	M 73/172	TS .		FTN	4.6+452	05/17/79	16.19.05	PAGE	1
			000000 NU 0100		TDUT T10010-TN					erunana 1 + P	
					TPUT, TAPE 10 = IN	UISTAPETES.	ALF 13%	<u></u>			
			TAPE 7 . OUTPUT	, IAPEL (, IAP	£201						
•			REAL LAMDA	NN KELEE NA							
e					AC,KALMAN,LOE,1	E I HKU J NUKE					
:-			COMMON /IDDA								
					AMIN, TS, TR, OME						
					AX, DELBL, NGM, IF					7	
					HO, TORO, BO, WS CO						
					+FL25(4)+FSAMP						_
10 '),GQGT(8,8),H(_	-
					LMN,NOAC,GAMAE:				·		
					,RMAT(5,5),PHI	(5,5),PA(8,8),LAHDA(5) 🝈				
			C O MMON/RC VR O								
			COMMON/RCVRC	8/XSfDE(8),	ESLDE(8),ES(8)	,		•			
15			COMMON/RCVRO	9/BRCVR, BB,	PDCRIT, CC						
			COMMON/RCVR1	0/XS1(8),XS	(8)" " "	•	-		~ ~ ~~~ ~		•
			COMMON/MLSOO	O/ALFA, THE,	THEOOT, ALFAR, TH	IR; THROOT, B,	WSC				
		**	COMMON/HLSGO	1/CSNRT, CSN	RF, DSNRDB, RHO, 6	ETA, FSC, LGM	AX		***************************************		
			COMMON/NLS GO	2/DCSNR,CSN	R, LG, TPKT, TPKF						
20			COMMONIMESOO	3/FL10AE(4,	2),FL10(4),DELT	AT(2), XO(8,	2},YO(4,2)				
			COMMON/MLSOO	4/BMLS.BBB.	MTIMES, MSET, HOP	E				•	
	(, H.		•	į	*		
	j	i c	CONTINUE								
•	·		CALL MLSSUB			****				** 1	
25 .			IF(MORE) GO	TO 10							
			STOP						******	-	
			END								
			4110								

•	FUNCTION THA	1 73/172 TS '		FTN 4.6+452	05/17/79 16.19.05	PAGE 1
		FUNCTION THA(T)		A THE WEST AND A COUNTY OF	14. b	
5	C	THIS COMPUTES THE ANTEN THE PARAMETERS OF THE S THE ANGLE FUCTION, ARE P	CAN WAVEFORM, HENCE	THE IDENTITY OF		
	- · · · · · · · · · · · · · · · · · · ·	AS FOLLOWS: TR=TIME BETWEEN TRAVERS TS=DURATION OF THE TO S TF=DURATION OF THE TO S	AL OF ZERD DEGREES	S IN A TO-FRO SCAN		
	, C THAN	IAX≖ANTENA ANGLE AT BEGIN IIN≖ANTENNA ANGLE AT END A≖ANTENNA ANGULAR SCAN R	NING OF TO SCAN OF TO SCAN		***************************************	- · · · · · · · · · · · · · · · · · · ·
. <u>1</u> 5		COMMON/RCVROO/THAHAX, THA T1=TS+TF IF(T.GE.O.O) GD TO 50 THA=THAHAX	HIN, TS, TR, DMEGA, TR			
20 .	50	RETURN IF(T.GT.TS)GD TD 100 THA=THAMAX+DMEGA*T RETURN			[
	100	IF(T.GE.TF) GO TO 200 THA=THAMIN RETURN	7 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2		(2	
		IF(T.GT.T1) GO TO 250 THA=THAMIN-OMEGA*(T-TF) RETURN	** I	M 1005 mc 3 4	. ,	· ·
. 30.	250	THA=THAMAX RETURN	mer une y mayor manorest to a	s so t s s com has me a		
41000B	CM STORAGE USED	. Talla SECONDS			AND AND AND AND AND AND AND AND	

SUBROUTIN	MLSSUB " 73/172 TS	-	FTN 4.6+452	05/17/79 16.19.05	PAGE 2
			en, y and y ar for and more than the deposit of the b		
	XO(4, IAE) = ALPHAR				***
60	XO(3,1AE)=P12+FSC	1		•	
	TSAMP=1./FSAMP	•	•		•
	OELT=DELTAT(IAE)				i
1 -	" F(2,3) +DELT		230 42 2000 00. /2 00 100 100	,, ,	* *1 *** * *
	F(5,6)=DELT				
65	F(7,8)=DELT		• • • • •		
	JM1=JM+1				
	TT JMZ=JM/2"	•			
	TWW2+0.5*TSAMP*(JM2+1)				
70	DO 30 I=1,8 X(I)=XO(I,IAE)				
70	30 "CONTINUE		•	,	
	CALL CONTRL(2)				
	C				nm - +
	C FOLG CALLS RECEIVER FOR INI	ITIALIZATION	-		
75 · ··· ··· ··· / ···	·c·				
	Ķ × 0				
	TO W CALL ROVE 37 THE PARTY				-
	C			W1 (**** * \$20000 U0	
0	C FOLLOWING BEGINS SIMULATION	N PER SE, LGMAX RUNS	UP KM SCANS EACH		
8u	Call contri(5)				
	DO 777 MMSET=1, MTIMES				
	" MSET *MMSET " ")=avr =	
	C				
85	" " CALL CONTRL(6) " "				
	DO 1 LGG=1,LGMAX				
	LG=LGG	2 m abe 2 (2 - 1/2 44) 2 mm = 10/1 =			,
	CALL CONTRL(7)				
	00 2 KK=1,KH	,		•	
90	K=KK				
	CALL CONTRL(B)				•
	IF (K .EQ. 1) GO TO 122	2 ** ** ***	manage and section to the contract of		
	C	-		2 %	<u>.</u>
-95 - '	C FOLLOWING ADVANCES THE	E TRUE STATE AND SAV	E PRIOR VALUE "	· · · · · · · · · · · · · · · · · · ·	Š.
	С			~ '	% .
•	DO 100 I=1.8			Õ	
	X1(1)=X(1)	and the state of a mercentarion of the state of the	rangago planes de am o 3 m 4 4	. 0	
	X(I)=0.			. "	OLEK.
100	100 CUNTINUE " DO 120 I=1,8				0.
	DD 110 J=1,8				(C. O.
	" X(I) + X(I) + F(I, J) + X1(J)			* *	S.L.
	110 CONTINUE				
105	120 - CONTINUE				2, 3
	B=PVALUE(B,PI,O.)			•	CLALITY
	C				
	C FOLG SETS THES PRIOR TO COM	MPUTING SAMPLE TIMES			
/	THES=XS(2)+DELT*XS(3)		. ,	· · · "	•
110	1F(.NOT.TETHRD) GO TO	124			
	122 - CONTINUE		•		
	- XS1(I)=X(I)-ED(I)	, ,			
	V2T/T1-V/T1-EG/T1				

	SUBROUTINE	MLSSUB	73/172	TS	•		FTN 4.6+	452	05/17/79	16.19.05	PAGE	3
115		ŢΗ	ES=XS1(2)	,) h #			
			NTINUE -					~ ~				•
•	* ·	C FOLG 8	EGINS COMPU	TATION OF SIGN	NALS AND	ELATED	QUANTITIES					
120		Ç.	KSI, CALCUL	ATION OF CONST	I VII S PU 1	HE PKES	ENI SCAN .	** * * *		rmalenna		
			2=ALFA++2 2=ALFAR++2									
		AA	Z=2.*ALFA*A ST=(THES-TH		., .			•			•	
125		TP	SF=TF+(THAM)	IN-THES)*SECP[D							
.		TZ	T=TPST-TWW2 F=TPSF+TWW2									
		C FOLG C	OMPUTES FOR MPOSITE SIG	THIS KTH SCAN	N THE SIGN RATIO CSN	AL PEAK	TIMES TPKT	TPKF AND		** -		
130		ŤP	KT={X{2}-TH	AMAX)+SECPD IN-X(2))+SECPD			• •	1e	• •			•
		C	•	•								••
	• ••	C PJ=PML	AJ=THA(TPKT S(THE→THA(T)=X(2), BY DEF PKT))=1.6,BY [FINITION DEFINITION	•••	₩.		•		**	
135		C AND SI	MILARLY FOR	TPKF							.*	
	rm nates		J=PMLS(X(5)	-X(2)) SC+TPKT,PI,0.1			.,		,,	- 		
140		8 F	PVALUE (B+W	SC*TPKF,PI,O.)							
240		d 1	F=AL2+AA2+PI	RJ*COS(BT)+AR2 RJ*COS(BF)+AR2								
			NRT≖SQRT(QJ' NRF≖SQRT(QJ			- 1.		•		. *** * * * * * *		
145	* ** '4 **			CSNRT, CSNRF) CSNRT, CSNRF)		: :	• 1 • •				~ •	
		^ CS	NR=CSNRMN	•		•	-				•	
		C ""	SNR=CSNRMX-	• • •	ė	•						
1 150		C FOLG I	NITIATES A . Velope samp!	J-LOOP TO COMP Le values	JAKĄŻ BTUŅ	E_TIMES	AND (LINEA	iR)	• in		'	
		00 ي	130 J=1>JM	2							•	
			NCR=J*TSAMP R=JM1~J	planter pr to testimina		- • •						4
155		IN	DEX (1)=J	and to solve the tree to be seen to be seen to be a seen to be see			name or a	~ , ,		/	_, , ,	
			DEX (2)=JFR OMPUTES SAM									
		_ TJ	=TZT+TINCR"		- ~		•				•	
160		` "`T(JFR)=TZF-TI	NC R" " " " "			w					•
• •		^ ^PJ	AJ=THA(TJ) =PMLS(THE-T			~ · · · · -					•	
		C FOLG C	J=PMLS(THR-' OMPUTES ENVI	THAJ) ELOPE SAMPLES								
165	•	DC	127 I=1,2 AL=INDEX(I)	* * *					·			
	****	XN	C=SQ22*GAUS: S=SQ22*GAUS:						1			
170		81,	DCAL=PVALUE	18+WSC*T(JVAL) 18+WSC*T(JVAL) 1+AA2*PJ*PRJ*C),PI,O.)	******	nn 14491	,		•		•
		01	#AMAX1(DJ.O	;	-us (BLUCAL	JTAKZ*(PKJ ##2]	•				

SUBROUTIA	NE MLSSUB	'3/172 TS	14 14	FTN 4.6+452	05/17/79	16.19.05	PAGE	4
175	11" UJ=QJ+S		XNS**2					•
	C " · ·	ING COMPUTES RECEI	IVER RESPONSES					
180	CALL RO		ATA FROM THIS SCAN	FOR FUTURE EVALUATI	ION			
185	C CONTINU		24 28 24 WARRING TO BE STORY TO			<u></u>		
	" C FOLLOWING A	ASSIMILATES DATA FF	ROM'THIS" LG-TH SET	OF SCANS				
190	CALL CONTINU	INTRL(10)	es de la la la la de la compansión de la seriente de la compansión de la compansión de la compansión de la comp					
	C FULLOWING A	ASSIMILATES DATA FE	ROM_THIS MSET—TH SE	RIES OF LGMAX SETS	OF KM SCANS		•	
195,	CALL CONTINU	INTRL(11)	a sea and before the sea on		gyat M & D		•••	•
	C FOLLOWING'	CLOSES THE SIMULATI	ION RUN				•	
200	CALL CO	ONTRL (12)		e sente s le la companie de la compa	u a k na mana -			
LOOOB CM STUR	AGE USED	1.399 SECONDS -	page in our products on par V in		, .,			
,				r - r		•		
	, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		MA	(at marps) 10 y 10 to 10	· · · · · · · ·		W ** ** A 1	
		ra a summerer ere ere er er e e e e e e e e e e		चीहर क्राचीर पान नेत्री है ।				
AM1 4 -			. फ्रांट सम्बद्धाः सम्बद्धाः सर्गास्त्रः स्ट	dan 3 haya wasa 12 d an	•	, O.	•	•
	AND THE RESIDENCE OF THE SECOND STREET, THE SECOND STREET, SECOND	. 4	w was and harrows in 1461444 w. treatment .		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	OR POOR	** ***	٠
,			Contraction of the Section particles for a secure of the section of	» («		70	, ,	
	, , , , , , , , , , , , , , , , , , , ,		ه ه پیشش اوا پیس و شیخ انسین			· · · · · · · · · · · · · · · · · · ·	,	
	and an area on the first of the second of the		remained assisted their election of their				· 2	
				, , , , , , ,	,	, e	三年	
	* # #### ****			• •			Ser to	
			ma rana dana na 16 di mara dinamina a sarkadinanana Asta Dimentini di Adrilli di Michael				_ &L	
						4		

	BLOCKDATA A	hLS "	73/172	TS '			FTN	4.6+452	•	05/17/79	16.19.05	PAGE
- •	· - ,	•				* 14-40-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-						
_			C DATA ML	S								
•			LAMDA			•	•	• •	•.	•		
						AN, LOE, TETHR	D. MORE		•	-		
-			ATADDATA								•	
?						L, NGM, IR, IAE						
		COMMI	1M/KC 4KGZ	/KHUMAX/	01HU31UKU	.BO.WSCO.NSO).FSAMP.K.KM	TEXUDO	43 40 No. 19				
						1, F3AAF, N, KA 8, B), H(5, 8),				_		
						C, GAMAES (5),						
16	•					,5),PHI(5,5)					•	
					B, PDCRIT,) FA (0) U	, CANDA () /				
						OB,RHO,BETA,	ESC. LGMA			·	~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~	
						(4), DELTAT (2						
	*** *				B, HTIMES,		.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		-	••	
15						NRDB/20./.RH	10/.5/					
		DATA	DELTAT/.	07407407	74,.024691	358/,SIGMA/.	7071/					
		DATA			,32.75,							
		*			12.,9,0.		•	••	. •		,	
						3E-3,6.6E-3,					1_	
20					E-3,0.4E-			•				
						.,75,0./						
					31,~.3033							
						M/100/, FSAMP			~			,
2.5					70.,1.,5 7 0 3/2,5,4,2/	1 و • 10+0 و • 1 و • 1	1.55+0.7					
			DELBL/.0					-				•
			GQGT/64+									
* ×						0/0.0/,80/0.	n/Ausch	/0.0/ * ····		•		•
						SE./,NOAC/.T					•	
- 30	1 - 1 - 2					68.0/.LGMAX/				~! ······		
						ES/1/, MORE/.						
		ATAC	IDNRS(5)	/1/				•			• • -	,
		END										
	*	,										
410006	CH STCRAGE	USED	.20	9 SECONO	20							,

SUBROUTINE DELTR1	73/172 TS		FTN 4.6+452	05/17/79 16.19.05	PAGE 1	• •
A despressing the parameters and the material desired of the state.	* * * * * * * * ***			1 At \$50,000 Transferred that a second secon		
DI S=	BROUTINE DFLTR1(X MENSION C(4) - " X-C(3)*C(4)			- ,		
5 C(C(1)*S+C(2)*C(4) 7	* *** ********************************		AND THE THE A DES ASSESSMENT SECRETARILY SECRETARILY AS A SECRETARILY ASSESSMENT OF THE SECRETAR		
EN EN	TURN					-
41030B CM STORAGE USED	.043 SECO	NDS				

SOUNDOI INE K	. AK 131,TIC 12		7 IN 4.04	492 09/1	1114 10-14-21	PAGE	•
	SUBROUTINE RCVR			o, 4 (4 4);-MMp			
	REAL LANDA, MJM2			.,			
		DLOE, NOAC, KALMAN, LOE, 1	ETHRD	•			
		AMAX, THAMIN, TS, TR, DME		·	**** ** ***		•
5		MIN, NGMAX, DELBL, NGM, IF					
		DMAX, DTHO, TORO, 80, WSC					
	COMMON/RCVR03/P1	F(8,8),FL25(4),FSAMP,	K,KM, TETHRO, NG, N	S-JH			
••	COMMON/RCVRQ4/DE	LT,E0(8),G0GT(8,8),H(6,8),ICOUNT,SIGMA	•	• •		
		LOE, NOKLMN, NOAC, GAMAES					
10 / - /		DIAG(B),RHAT(5,5),PHI	(5,5),PA(8,8),LAM	DA(5)		*****	•
	COMMON/RCVRO7/T(,		
		LOE(8), ESLOE(8), ES(8)					
	COMMON/RCVRO9/BR COMMON/RCVR10/XS						
.15	COMMON/MLSOOO/X(
		8),PHT(8,5),TPA2(8,8)	. TVNC (5.)	!-		ь	
	DIMENSION RVNG (5		720110157			•	
с				* * * * * * * * *	., ,		
_	1F (K .GT. 0) GD	TO 40 .					
20 ` ' C	FOLG IS INITIALIZATI		•				
	P12=2.+P1	•					
	~ SS2=.5/(SIGMA++2	,	ì				
	CALL PHILM		•				
	' NS=NSO(IR)		• •	• • • •	11	• •	
25	NG=NGD(IR)		_				
-	NGMIN=2		•	_	-		
	NGMAX=NGO(IR)						
	GQGT33=.01*DELT GQGT(3,3)=GQGT33						
	GQGT(6,6)=GQGT33						
30	GQGT(8,8)=.04/(D	FLT##21					
•	00 20 I=1.NS "		-			,	
	DO 10 J=1,NS				•		
	PA(I,J)=0.						
35 10						•	
20				*** ** * * * * * * * * * * * * * * * * *	. ,		
_	CALL CONTRL(3)						
-	88=2.4/BRCVR		•				
40	. PDCRIT=PI*BB/8.						
70	CC*PI*POCRIT IF(IR.GT.O) GO T	n 20					
	NS=NSO(4)						
	NG=NGD(4)						
30	CONTINUE	m	•	•	•		
45	NGM=NGMIN						
	TIF(NOAC) NGM=NG						•
	KALMAN=.NOT. NOK	LMN .					
	" LOE=.NOT. NOLOE						
	CALL CONTRL(4)						
50	RETURN						
40		سيست در المجتمعة					
^	1 1F(K:GT.1) GO TO	50 ' '' '' ''	: ::				
C	DIACNOSTIC CHICAGO TOS		DE 6'UE 6	,			
55 C	ATMONDSTIC MAILANT OF	"INPUT 'DAYA' FOR' K=1 G	NE2 HEKE				
<i></i>	GO TO 90		•				
50							
• •	····						

· s	UBROUTINE	RCVR	73/172	TS	•	FTN	1 4.6+452	05/1	7/79 1	6.19.37	PAGE	
				STATE ESTIMAT	E AS REQ.D							
60			IF(TETHRD) GO DO 70 I=1,NS	TO 80				~ .		ad ka, ka h, , , , , ,	. ,	
•			XS1(I)=0. 00 60 J=1,NS			•	. , ,					
۰ 5 م		60	XS1(I)=XS1(I) CONTINUE CONTINUE	+r(1)J)*X3(J)		f p+						
0,5		80	CONTINUE CONTINUE	•	••							•
***		C		.25,.01+(XS1()	()**2))****					,		
70			GQGT(1,1)=GQG GQGT(4,4)=GQG								•	
		C NG)	PHI(NG, NS) AL	S VECTORS Q(J) SO SQUARED AMP	LITUDE ENVEL						· 1	1
75 ***		C	CALL PHILM	SS VECTOR W(J)	1.) 				***	1		
		r	IF (NOLOE) GO	TO 120		- •					•	
80	,	• •	CALL MATINV(R	T=PHI-INVERSE MÅT,5,NG,IVNG,		, ,				***	·- ·· ·	
		-	DU 100 I=1,NG RDIAG (I)=RMA						,			
- 85		•		5, NG, NG, 5, NG, 1 5, NG, NS, 5, NG, 1					,			
		,	DD 110 I=1,NS XSLOE(I)=XS1(I)+ESLOE(I)		,	'- '- '-	• •				•
90		110	CONTINUE "	\$(1)=X\$LOE(1)`				٠		•		•
		c	IŁ (NOKĽWN) è	O TO 170	, r	-		/ - 4/		بالمستوان والمستوانية والمدادة		
95		ç · · ·		TRAPOLATES STA ATRIX PA(NS,NS		• ERROR			-	· ·		
	,			20 i 20 i 8 i 20 i 20 i 20 i 20 i 8 i 20 i 20 i								
100			CALL MATSM(PA DO 130 I=1,NS	, PA, GQGT, 1, 8, 8			,	*** * ****** *			•	
,, ,, ,, ,			PMDIAG (I)=PA CONTINUE	(1,1),					•			
135		C	'EDFÍOMING CÔ	MBNĪEZ MODIÈÍE	D-KALMAN GAJ	N MATRIX	GAIN(NS,NG)			WR 19700		
103		•	CALL MATHUL(5	, N S , N S , 5 , N G , N S , N G , N G , 5 , N G , N S , N G , N S , 8 , N S , N G	TeHeIH9eBeBeB	PA1.11				-,446. 18		
. 110		•	DO 140 I=1,NG TPA2(1,I)=TPA CONTINUE	- , ,,		*1 * 1 227 **					·	
			CALL MATINY(T	PA2,8,NG,IVNG, ,NS,NG,8,NG,NG		2,GAIN,1)	n .					
		Ç										

SUBROUTINE KCVR	73/172	TS		FTN 4.6+452	05/17/79	16.19.37	PAGE	3
,		***	memory lact with at he s. s.e. A	11 m				•
_ 115 C	CALL MATMUL (8	DATES STATE ESTI B, NS, NG, 5, NG, 1, 8, B, XS1, ES, 1, 8, 1, 8,	1,GAIN,LAMDA,ES,	1)			,	;
	FOLLOWING UPO	DAŢĘŚ STATE ESTI	ATEERROR_COVAR	IANCE MĄTRIX				# ***** #
and the second second	DG 150 I=1,NS		8,GAIN,TPA1,TPA2	(I)			•	
125 150	TPA2(I, I)=TPA2	2(1,1)-1.	h		,24 01/2 5			
mental billion and column demand and deline a till of the			8,PA,TPA2,TPA1,3 1,PA1,PA1,PA1,PA1			14 p		
			,8,PHI,GAIN,TPA1, ,8,GAIN,TPA1,TPA2		* /* * *		***	
	"CALL MATSM(PA) DO 160 I=1,NS	PA, TPA2, 1, 8, 8, 8.	NS,NS,B,NS,NS,O)					
160	PPDIAG'(I)=PA	(P1)						•
	CONTINUE							
135	IF (NS.GE.7) : RETURN TO THE END	XS(7) =PVALUE (XS(7)+PI+O+)	•		HS & LOSSEMAPOR 3 .	*	
410008 CM STORAGE USE		Z SECONDS						
ATARAGE ON STOKNAE OFF		でっていいりつ						

BLOCKDATA DRVR	ID 73/172 TS		FTN 4.6+452	05/17/79 16.19.37	PAGĘ 1

	BLOCK DATA DRVRID COMMON /IDDATA/IDNRS(6) DATA IDNRS(4)/2/			, ,	,
	END	į	,	, , , , , , , , , , , , , , , , , , , ,	, 1
' 41000B CH STORAGE USE	D			* } / 2 \C f 4 H PARENTALAN 6 1/4	

SUB	ROUTINE RCVR	73/172 TS	•	FTN 4.6+4	52 0	5/22/79 13.36.34	PAGE 1
	p	SUBROUTINE RCVR REAL LAMDA, MJM2		2 to the street Control and Section 2 day to the se	# F PPL #104		
		LOGICAL NOKLMN, NOLOE, COMMON/RCVROO/THAMAX, COMMON/RCVRO1/NGHIN, P COMMON/RCVRO2/RHOMAX,	THAMIN, TS, TR, DI NGMAX, DELBL, NGM	HEGA, TF IR, IAE			
		COMMON/RCVR03/PI,F(8, COMMON/RCVR04/DELT,EC COMMON/RCVR05/NOLOE,E	,8),FL25(4),FSA D(8),GQGT(8,8), NDKLMN,NDAC,GAM,	1P,K,KM,TETHRD,NG,NS, 1(5,8),ICOUNT,SIGHA NES(5),RDIAG(5),PHDI	AG(8)		
10		COMMON/RCVRO6/PPDIAG COMMON/RCVRO7/T(130)	V(130)		A(5) -	*******	
15		COMMON/RCVRO8/XSLDE(COMMON/RCVRO9/BRCVR, COMMON/RCVR10/XS1(8), COMMON/MLSOOO/X(8)	BB, POCRIT, CC			F.O. AMAN , & STM:1000 PERSON P. 1.27.5	
		DIMENSION TPAT(8,8), I DIMENSION RVNG(5), GA:	PHT(8,5),TPA2(8. IN(8,5)	8),IVNG(5)			
20	C FOL	IF (K .GT. 0) GO TO 4	40				***************************************
		PI2=2.*PI \$\$2=.5/(\$IGHA**2)					
25	P 4 10 40	CALL PHILM NS=NSD(IR)				= x-2-2-1-7 (= 1-2-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1	.,
²⁵	• •	NG=NGO(IR) NGMIN=2 NGMAX=NGO(IR)	• •		•		
		GQGT33=.01+DELT GQGT(3,3)=GQGT33		•	4	,	
30	of him to be made on a	GQGT(6,6)=GQGT33 GQGT(8,8)=.04/(DELT*)	*2)	Named State & St. Victor in	11 m 5 c m 5)	
•••••		DO 20 I=1,NS " 1			***		*
35	10	PA(I,J)=0. CONTINUE	474 4 4 44 4 5004	· · · · · · · · · · · · · · · · · · ·	. , , , , ,		
	20	CONTINUE CALL CONTRL(3) BB=2.4/BRCVR			٠ -		
40 -	4 / 4 444 / /	. PDCRIT=PI*BB/8. CC*PI*PDCRIT				***************************************	
مد عد دوست.		IF(IR.GT.O) GO TO 30 NS=NSO(4) NG=NGO(4)	a months solvette for some the fact of a	and decoupe and a second		***************************************	
	_, _ 30.	CONTINUE		•	•	, , , , , , , , , , , , , , , , , , , ,	
	,	IF (NOAC) NGM=NG' " 'KALMAN*.NOT. NOKEMN				. M. ,	
	er peng t a yet forme	LOE=.NOT. NOLDE CALL CONTRL(4)	्राच्या चार्यच्या इत्यासम्बद्धाः इत्यासम्बद्धाः इत्यासम्बद्धाः इत्यासम्बद्धाः इत्यासम्बद्धाः इत्यासम्बद्धाः इत	n de 14 r de de de de .	- Print 1 3		**************************************
50	40	RETURN CONTINUE		,		, to the second of the contract of the contrac	
	C DIA	IF(K.GT.3)"GO TO 50 GNOSTIC OUTPUT OF INP	::	'CUES HEDE'			
55	C	GO TO 90	OI DAIR FUR K=1	ANES HEVE			-)
	50	CONTINUE					

OPTRVR Page 1 of 4

SUBROUTIN	E RCVR	73/172	TS	, 1	FTN 4.6+452	05/22/79	13.36.34	PAGE 2	
	•			** *	* , , , ,				
		XTRAPOLATES (TETHRD) GO	STATE ESTIMATE,	AS REQ.D .	1+++ #	,,			
60	, , , , ,	70 I=1,NS 51(I)=0.	,		•	- ,			
	^` xs		+F(I,J)*XS(J)	1 10 0 10 10	94 F 36		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		
. 65	70 CC	INTINUE INTINUE INTINUE							*** ***** :
•		NTINUE							
70	, GC	RGT11=AHAX1(; RGT(1,1)=GQG RGT(4,4)=GQG		¥2))		4 4 2			-
••	C FOLLOW	ING COMPUTE:	S VECTORS Q(JM),	HW(JH),LAMDA(NG),/ TUDE ENVELOPE VECT	AND MATRICES DT	(JH)			
75	C INDVAT	ION; S PROCE	SS VECTOR W(JH)	TODE ENVELOPE VEC	IDK OCOMITYAND,				
		LL PHILM GO	TO 120 '	•			~ .		
			T=PHI-INVERSE AND 1AT,5,NG,IVNG,RVI		,	m= , ,	-u q Trus e 20 100 100 100 100 100 100 100 100 100	هري نوما مستحدده المعاونة المع	
	DO	100 I=1,NG	, , , , , , , , , , , , , , , , , , ,	10)		• •			, .
85	C.A			,1,RMAT,LAMDA,GAH,					
#INT 1/H # 1 # *	´ DC	NEL MAINUL (;) 110 I=1,NS (LOE(I)=XS1(;		,1,H,GAMAES,ESLOE,	,, ,, ,,		e pitulus Tundul suuraanuvanavanuva vanassuu saarassu		
90	IF		(1)=XSLOE(1) ·		_		** * * * * * * * * * * * * * * * * * *		
10 1		NTINUE : (NOKLMN) G(70 170	4					
95			TRAPOLATES STATE ATRIX PA(NS,NS)	ESTIMATES, ERROR	•		* ***** - 1	- -	
			. 8 . 2 N . 2 N . 2 N . 2 N . . 8 . 2 N . 2 N . 8 . 2 N . 2 N .						
100	C A	LL MATSH(PA) 130 I=1,NS	PA, GQGT, 1, 8, 8, 8	NS, NS, 8, NS, NS, O)	••	,	الله المساور والمرابع المسادقة المسادقات المسادقات المسادقات المسادقات المس	manage and perception of	•
		DIAG (I)=PA: Intinue	(I,I) ·		,				. , ,. ,.
105 " " "	Č , F	OFFOMING CO	HPUTES MODIFIED-	KALMAN GAIN MATRIX	(GAIN(NS,NG),	VI 11 ***			
1	CA	LL HATHUL(5)	NS	8, PHI, H, TPA1, 1)					
110	DC) 140 I=1,NG	• !	8, TPAL, PHT, TPA2, 1	ι) ,	٠ ٠.			
110	140 CC	PAZ(I,I) ETPA: Intinue LL Matinu(ti	PAZ>B>NG>IVNG>RVI		<i>*</i> }		H 1964 O Old He H I Miles brokel, high it was a biguripus salampel ye	ngh -d -y 2-mgs b 6-yan nd y 6 y y -d	
				5, PHT, TPA2, GAIN, 1	L)		• • •		

JOBNOTZNE NOT	137112 13	FIR 4404422	02722714 1	13430437	FAGE 3	,
, 115 C	FOLLOWING UPDATES STATE ESTIMAT CALL MATMUL (8, NS, NG, 5, NG, 1, 8, 1, CALL MATSM (XS, XS1, ES, 1, 8, 1, 8, NS	GAIN, LAMDA, ES, 1)	~		,	
120	FOLLOWING UPDATES STATE ESTIMAT P(NS,NS)	E JERROR COVARIANCE MATRIX	a its d some to some statement of the source of the statement of the source of the sou			
	CALL MATMUL(8,NS,NG,8,NG,NS,8,8, DO 150 I=1,NS TPA2(I,I)=TPA2(I,I)=1.	GAIN, TPA1, TPA2, 1)	1 7 m 2 mmmm mm			
125150	CONTINUE CALL HATHUL(8,NS,NS,8,NS,NS,8,8, CALL HATHUL(8,NS,NS,8,NS,NS,8,8,8,	TPA2, TPA1, PA, 1)	er mar 'n'e sûn en sûnd erstrementelsteren			
130	CALL HATHUL(5,NG,NG,B,NS,NG,B,B,B,CALL HATHUL(8,NS,NG,B,NG,NS,B,B,B,CALL HATSM(PA,PA,TPA2,1,B,B,B,B,NS	GAIN, TPA1, TPA2, 1)				
160	DO 160 I=1,NS PPDIAG (I)=PA(I,I) CONTINUE		mand if a column was assumed			
135	CONTINUE XS(1) = ABS(XS(1)) AN=(THAMAX+THAMIN)/2.		hr	•		
	XS(2)=SATU(XS(2)-AN, (THAMAX-THAM IF(NS.GE.3) XS(3)=SATU(XS(3),1.) IF(NS.GE.4) XS(4)=SATU(ABS(XS(4)		s. It had not any and had a dispussment		······	
140	MJH2=FLOAT(-(JH/2+1)) THWW2=HJH2*OHEGA/(2.+FSAMP) AHX=XS(2)+THWW2					
145	AMN=XS(2)-THWW2 AN2=(AMX+AMN)/2. IF(NS.GE.5) XS(5)=SATU(XS(5)-AN2	/ (AHX-AHN)/2.)+AN2	,, he as see hanne			
-	<pre>IF(NS.GE.6) XS(6)=SATU(XS(6),1.) IF (NS.GE.7) XS(7)=PVALUE(XS(7), IF(NS.GE.8) XS(8)=PVALUE(XS(8),P</pre>					
150''	RETURN END		ستعوري عند وعنو معم وحدو وو			- -
41000B CH STORAGE USE	D 1.381 SECONDS	•				

DE POOR QUALTIN

A-69

SUBROUTIN	E PHILM	73/172	TS			FTN 4.6+4	52	05/17/79	16.20.18	PAGE	1
	cua cuan	OUTINE PH	,.								
** **	ς 208Κ	DOLLNE PR	ILI		•		-	** ** *			
,	ČTHIS SUBO	PTIMAL VE	RSION OF	PHILM IS					~		* ** 41
_				METER VECTO							
5					ISITION						
	CA FUNCTIO			OM2							
				NGM.LT.NGMA	х						
										,	
10	C			1-2							
	C										
		FDS NGWIN	LE.NGM (·LE·NG) ·LE	.NGMAX						
•			IN . NOLDE . N	DAC, KALMAN,	LOE.TETHRO						
15				MAX, DELBL, N							
				THO, TORO, BO							
1 P N 4 A 7 4						TETHRO, NG, NS.	۰۰۰۰ الرو	4 67 60 to MINESON			
						COUNT,SIGMA DIAG(5),PMDI	10101				
20 1 -						PA(8,8),LAMD					
			/T(130),V								
					FAR, THRS, T	HRSDT.B.WSC.	XS(8)				
\$15 N 1 15 N 1 1 2427			RL(4			4011 4014 04				······································	
25						(3)),(RL4,RL PH22,PH(2,2)					
				PH(3,2))							
						3)), (PH44,PH	(4,4))				
	C										
30	ີ ດີ ເດິ່ງຕ້ານໄ	NG FFFFC	S INITIAL	TEATTON "				,, .,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			
_	C										
-		.GT.O) G(ÎTO 10 🍈			• •	•				
		JM/2				•	-				
35		JM+1 .5/(SIGM/	++21								
37	IR=3				•		•				
-	RETU	IRN _				_					
		INUE		,	-	•					,
40	CA FOLLO	ULTUC BROK		***		•		·			
40	CA FULL	MING PRU	RAMS THE	SEAKUN					,		
		GM.GT.NG	IIN) GO TO	30			- ***	* * * * * * * * * * * * * * * * * * * *			
	_ ALFA	R=ALFA*RI	MAX				, ,				
		- THES-DTH	10			,					
. 45	8 = B C	DT.TDRO		700 jes	••• •			·			
		wsco									
		INUE			•		+	· · · · · · · · · · · · · · · · · · ·			
	C										
50	C FOLLOWI	NG COMPU	TES CONSTA	NTS FOR PRE	SENT SCAN						
¥ 4	Δ12±	2.*ALFA	· · · ·		- ·		į				
		*ALZ*ALF	A								
	AR2.	2.*ALFAR	1			, ,	. , ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,				
, 55 ,		=AR2+ALF									L 00
		ALZ#ALFAI									

PLSUB Page 1 of 8

	SUBROUTINE	PHILM	73/172	TS	•	` F	TN 4.6+452 "	05/17/79	16.20.18	PAGE	2
		-						*************			
		ï	00 35 I=1.NG								
		1	RL(I)=0.		•			,			
60			00 34 L=1,I	•	•		•				
			PH(I,L)=0. Continue					, max			
		С		-					,		
				TES LOOP AND (COMPUTES FUN	CTIONS	•				, m, n,
65			EACH J								
	•	1	00 60 JI=1,JM		* * * * * * * * * * * * * * * * * * * *		1-	,,	,		
	~~~~		THAJ=THA(T(JI THES=THES=THA		** ******						
. 70											
			PDJ=PDOT(THE8	i)		, ,					
			P2J=PJ++2 Ther=Thrs—Tha		w , , , , , , , , , , , , , , , , , , ,			JE p		,	
			IHEK=IMKS−IMA PRJ±P(THER)								
75			PORJ=PDOT(THE	R)					I .		
			PR2J=PRJ**2				•		)		
			PPRJ=PJ*PRJ PAJ=.5*AL22*P	2J '							
•	• •		3 A = O .	, , , , , ,			,,,	. ,			,
. 80			)AJ1=AL2+P2J	·nn 1	• •		• • •				
			)AJ2=AL22*PJ* DBJ1=0.	PUJ							
		1	D&J2=0.	•		•	•	, ,, , , , , , ,			
85			IF (NGDEL .LT Qaj=qaj+.5+ar	• 0) GO TO 40							
			DBJ=AA2+PPRJ	ZZTFRZJ				······································	<u> </u>		
- ,-			BA=SIGN(0.989						1		
			IF (QAJ.GE.1. DBJ1×AR2+PPRJ		(AMIN1(0.989	9999, ABS (	QBJ)/QAJ),QBJ).		<u> </u>		•
90	•		DBJ2=AA2*PDJ*					. P	<u> </u>		_ ,
			DAJ3=AR2+PR2J					POOP ROOM	5		
			)BJ3=AL2*PPRJ )AJ4=AR22*PDR		t hm or	•		· · · · · · <del>/2</del> ] -			
		, (	<b>9*L9*S&amp;&amp;=+L8</b> C				*	. 0.5	<u> </u>		
95	•		CONTINUE					QUA	*		
	• •		GAJ∓AMAX1(O.)	(LAD,839999999	•				<b>1</b>		• ••
	- بن ت		J1=SS2*V(JI)*	*2	**		••	· · · · · · · · · · · · · · · · · · ·	، ، ، مندسم،		<b>"</b>
,			U2=SS2+V(JM1→					7K (	Ņ		
100				/Al,WBl,QAJ,BA; /A2,WB2,QAJ,BA;						•	
,	- 41	!	MY=MY1+KŸS	,							•
			WB=WB1+WB2	CA. CO. O. O. O. I	. 0 4 3				•		
105			RAB1=RAB+1.	SA, SB, RAB, QAJ	IDAJ ""	u.*	и мут 4				
	,	1	RL1=RL1+DAJ1*				•				
•			RL2=RL2+DAJ2* SDA1=DAJ1*SA	WA+DBJZ*WB							
			SDA2*DAJ2*SA		* * *		•	•	·· -	,	
110	- 1		SDB1=DBJ1+S8			. '	•	, mes (ev			
	٠, ۲		SD82*D8J2*\$8	.1							
		. !	9	12					•		
				1+*2+RAB1*2.*	SDA1*SDB1				*		

	E PHILM	73/172 TS	·	FTN 4.6+452	05/17/79 16.20.1	8 PAGE 3
15 .	Ī	PH21=PH21+DSD1+DSD2+RAB PH22=PH22+DSD2++2+RAB1+ IF (NGDEL .LT. 0) GD TC	2. +SDA2 +SDB2	B2) .		- x
	Ī	1F (NGDEL .L1. O) GO 1C RL3*RL3+DAJ3*WA+DBJ3*WE RL4*RL4+DAJ4*WA+DBJ4*WE	<b>.</b>			* * * * * * * * * *
20 - 05		AZ*ELAG=EAG	*			
-		SDA4=DAJ4+SA . SGB3=DBJ3+SB		•		
-		S084=08J4*S8 DSD3=SDA3-SD83		•		
25		DSD4*SDA4~SDB4 PH31*PH31+DSD1*DSD3+RAE	 	m		
		PH32=PH32+DSD2*OSD3+PA[ PH33=PH33+DSD3**2+RAB]	1*(SDA3*SD82+SDA2*SD			
		PH41=PH41+DSD1+DSD4+RAE	1+(SDA4+SDB1+SDA1+SD		A	
30		PH42=PH42+DSD2*DSD4+RA{ PH43=PH43+DSD3*DSD4+RA{	1+(SDA4+SD83+SDA3+SD			
		PH44=PH44+DSD4**2+RAB1* CONTINUE _	*2.*SDA4*SDB4		, , , , , , , , , , , , , , , , , , , ,	
35	60 C	CONTINUE				
	Č FOL	LOWING COMPUTES VECTOR	LAHDA(NG) AND HATRIC	E PHI(NG,NG)	4 4 5 W	
		DO 110 I=1,NG LAMDA(I)=RL(I)	, ,		, , > \ ( - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -	, ,
40		DD 100 L=1,I	* *			part and compressions of the E
•• • •		PHILI=2, #PH(I, L) PHI(L, I) = PHILI	** ** ** *	•	. بر مرید با در	
		PHI(1,L)=PHILI IF (NOLOE) GO TO 90	4	* * *	y the same and the	
45		RMAT(L,I)=PHILI RMAT(I,L)=PHILI				
**	90	CONTINUE		••	,, _, <u>,</u> _, _, _	
	110	CONTINUE "				·
.50						

SUBROUT	INE WAWBJ	73/172 TS	. , , ,	FTN 4.6+452	05/1///79 16,20,	le PAGE 1
h	•					•
·	ç	* * * * * * * * * * * * * * * * * * *		• -	- 11 1 1 - 101	
	č	1				
	č					,
E	Č					
. 9			y with a line was a		24 24 1 1 may 17 market management	
	· ·	SUBROUTINE WAWBJ(WA,WB,QA	- 0 - 113			
• • • •		OMPUTES A SAMPLE EACH OF		UR.		, , , , , , , , , , , , , , ,
		SAMPLES OF GA,B, AND U	THE TROCESSES WAY	,		•
10		OGICAL NFIRST	•	**		
10		DIMENSION HA(11), HB(11), C	ns8(11).6(11).H(11)			
		DATA LMAX/10/, NFIRST/.FAL				
	c	7417 CHAMILOV, HI 21101711 AC				
•		(F(NFIRST) GD TD 10		•	- •	
15		MAX1=LMAX+1		,		
		RLMAX1=LMAX1		-		
		ALNEMX=ALOG(REMAX1) .				
		BETA2=3.1415927/LMAX	, , , , , , , , , , , , , , , , , , , ,		· •	•
		00 5 L=1,LMAX1				
20		COSB(L)=COS((L-1)*BETA2)				
7.		CONTINUE				
		VFIRST = . TRUE .	• • •			
		CONTINUE	, , , ,	. ,		
, ,		SMAX=-1.E+322				
25	´ ′ I	HMAX=1.				
• •		IAMAX=1.				
	, I	IBMAX=1.				
•		00 20 L=1,LMAX1			•	
** 1 743.4 */		COSBL#COSB(L)	, , , , , , , , , , , , , , , , , , , ,			,
30	C BCBL	1=AMAX1(1.+B*COSBL,0.)				
		BCBL1=1.+B*CDSBL ,	,			,
		ABC=QA*BCBL1		•		
•		JABC=U*ABC	* * *		, ,	
		RAD=2.+SQRT(UABC)				(C) (C).
35		RADI=SQRT(1.+UABC)				
		GL=2.+(RAD1-1./(1.+RAD)}-	ABC		•	ORIGINAL OF POOR
		S(L)≈GL			, ,	
		IL=1./SORT(1.+6.2831846#R	(AD)			¥ <b>₹</b>
		{(L)*HL				₩ ₩
40		AL = (~1.+U/RAD1)*HL				
		IA(L)=HAL				PAGE I
		HBL=HAL*COSBL				
		18(L)=HBL				, <b>5</b> &
		SMAX#AMAX1(GL,GMAX)				
45		HMAX=AMAX1(HL,HMAX)	• (			
		HAMAX=AMAX1(A85(HAL),HAMA				
•		HBMAX=AMAX1(ABS(HBL),HBMA		•		A word on the second state of the second
		CONTINUE 5Z∞GMAX~741,				
5.0		52=GNAX-741, FZ=ALDG(HMAX)+GZ				
. 50		rz=alug\nnaxj+gz 3M=FZ+ALNLMX				
		SZ#GZ+ALNLMX	•			- 1 -
•		SMA#GZ+ALNCHX				
·		CHB*GZ+ALOG(HBMAX)		•		
5 Š		FS=O.				
99		FSA=0.	•			
•		-S8=0.				
			• •			,

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P
-

			** * **** *					
0 30 L=1,LMAX1							<del></del>	
G					•			
LM=GL-GH			11					
LMA=GL-GMA								
LMB≖GL-GMB								
F(GLM.GE674.	) FS=FS+EX	P(GLM)*H	(L)				•	
.F(GLMA.GE674	) FSA#FSA	+EXP(GLM	A) *HA(L).					
					7			
CONTINUE								
(XAMH\XAMAH) #AS	*(FSA/FS)							
(B = (HBMAX/HMAX)	*(FSB/FS)							
ETURN					.,			
ND .								
	L=G(L) LM=GL-GM LHA=GL-GMA LHA=GL-GMB F(GLM-GE674 F(GLMA-GE674	LM=GL-GH LMA=GL-GHA LMB=GL-GHB F(GLM.GE674.) FS=FS+EX F(GLMA.GE674.) FSA=FSA F(GLMB.GE674.) FSB=FSB CONTINUE (A=(HAMAX/HMAX)*(FSA/FS) (B=(HBMAX/HMAX)*(FSB/FS) ETURN	L=G(L) LM=GL-GM LHA=GL-GMA LHA=GL-GMB F(GLM-GE674.) FS=FS+EXP(GLM)*H F(GLMA-GE674.) FSA=FSA+EXP(GLM F(GLMB-GE674.) FSB=FSB+EXP(GLM F(GLMB-GE674.) FSB=FSB+EXP(GLM F(GLMB-GE674.) FSB=FSB+EXP(GLM INTINUE LA=(HAMAX/HMAX)*(FSA/FS) LETURN	L=G(L) LM=GL-GM LMA=GL-GMA LMA=GL-GMB F(GLM.GE674.) FS=FS+EXP(GLM)*H(L) F(GLMA.GE674.) FSA=FSA+EXP(GLMA)*HA(L) F(GLMB.GE674.) FSB=FSB+EXP(GLMB)*HB(L) CONTINUE LA=(HAMAX/HMAX)*(FSA/FS) (B=(HBMAX/HMAX)*(FSB/FS) ETURN	L=G(L) LM=GL-GM LMA=GL-GMA LMA=GL-GMB F(GLM.GE674.) FS=FS+EXP(GLM)*H(L) F(GLMA.GE674.) FSA=FSA+EXP(GLMA)*HA(L) F(GLMB.GE674.) FSB=FSB+EXP(GLMB)*HB(L) CONTINUE LA=(HAMAX/HMAX)*(FSA/FS) (B=(HBMAX/HMAX)*(FSB/FS) ETURN	L=G(L) LM=GL-GM LHA=GL-GMA LHA=GL-GMB F(GLM.GE674.) FS=FS+EXP(GLM)*H(L) F(GLMA.GE674.) FSA=FSA+EXP(GLMA)*HA(L) F(GLMB.GE674.) FSB=FSB+EXP(GLMB)*HB(L) CONTINUE LA=(HAMAX/HMAX)*(FSA/FS) (B=(HBMAX/HMAX)*(FSB/FS)	L=G(L) LM=GL-GM LMA=GL-GMA LMB=GL-GMB F(GLM.GE674.) FS=FS+EXP(GLM)*H(L) F(GLMA.GE674.) FSB=FSB+EXP(GLMA)*HA(L) F(GLMB.GE674.) FSB=FSB+EXP(GLMB)*HB(L) CONTINUE LA=(HAMAX/HMAX)*(FSA/FS) (B=(HBMAX/HMAX)*(FSB/FS)	L=G(L) LM=GL-GH .LM=GL-GHA .LM=GL-GHB F(GLM.GE674.) FS=FS+EXP(GLM)*H(L) F(GLMA.GE674.) FSA=FSA+EXP(GLMA)*HA(L) .F(GLMB.GE674.) FSB=FSB+EXP(GLMB)*HB(L) .CONTINUE .A=(HAMAX/HMAX)*(FSA/FS) .E=(HBMAX/HMAX)*(FSB/FS) .E=(HBMAX/HMAX)*(FSB/FS)

SUE	ROUTINE SWF	CNS 73/172 TS		FTN 4.6+452	05/17/79 - 16.20.18	PAGE 1
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	č				240 2 7 70 700 70 70	
	Č					
. 5	C	- •				
	С					
		SUBROUTINE SWECKS (HE	(AJ,HWBJ,RABJ,QAV,B/	1)	(m r v <del>m</del> r	
		INTEGER FNA(4) LOGICAL NFIRST				
10		DIMENSION BULK(12,25	5.31.0A(251.B(251.D)	X(24) DEY(11)	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
~		DIMENSION AA(3), BB(3			A	
		DIMENSION OAB(25,2),	QB(2),1QBHAX(2),1Q.	18(2)		
	-	EQUIVALENCE (QA(1),				
		EQUIVALENCE (IQMAX.)				
. 15		EQUIVALENCE (19,19)		84,48(2))		
		DATA FNA/10HMLSLOGSV DATA NFIRST/.FALSE./				
	с	DATA WEEKSTFEFACULES	•		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
		LG GENERATES TABLE FRO	M DATA FILE		·	
20	Ċ					
		IF(NFIRST) GO TO 10				•
		NFIRST=.TRUE.	THE ALTO COMOLOGES			
	•	IX=IATTACH(6LTAPE12)		•	,	
25		IF (IX.EQ.O) GO TO 5 CALL INTIO(6HIXAT12;				
25		STOPPINPUT FILE ATTA		ISFACTORY#	•	
	. 5	CONTINUE				
	• •	READ (12) IDUM, IDUM				
-	•	, READ (12) IOMAX, (OA)		• •		
30		READ (12) JBMAX, (BC.		T TORIVE U_4 ME		
		READ (12) (((BUL)	((J,I,K),J=l,JBMAX);	1=1914UVX39K=1933	• •	•
		00 3 I=1,IQM1				
	3	DEX(I)=QA(I+1)-QA(I)	,			
35	•	JBM1=JBMAX-1				
		DB 6 I=1, JBM1				
	6	DEY(I) *B(I+1)-B(I)			man man man and a ma	
		IQ~IQMAX/2	,			
40		IB=JBMAX/2 CALL RETURN(6LTAPE12	,			
70	10	CONTINUE	• •			
•	ì i c	a dout them	•		/	
	Ç FC	ILG TRUNCATES ARGUMENTS	S AND HANDLES SHALL	BV CASES		
	С					
45		BV=ABS(BA)				
		<pre>IF (BV .GE01) GO HWAJ=1./SQRT(1.+2.*</pre>				
		HWBJ=0.	1941 · **	• •	, ,	
		RABJ=0.				
50		RETURN			,	•
- 4	20	CONTINUE				
	Ċ	-				
	C FC	LG DETERMINES IQ. IB		•		
		QB(1)=QAV				
55		DD 1500 L=1,2 OBL=08(L)				
	. 1001	TF(ORIALTAGAR(TGJR()	3.(3) GO TO 1101			

SUBROUTINE SI	WPCNS :	73/172	TS			FTN 4.6+452	:	05/17/79	16.20.18	PAGE	2
		•				. 14 1-					
	701003	. 7 0 1 0 1 1 1		•							
• •		IQJB(L)			•	-					
		IXAMBOI						. `			
60			Р1, ІОВМИН								•
***			I,L}} GO	18 1202							
120								,		<del></del>	
120	02 10JB(L)										
	GO TO 1						•				
65 110	Ol IOJEM1:									•	
		1-1,19									
•		JBM1-I+									
ter many reserve to be appropriate.			MHII,L]).	GO TO. 1302.				· · · · · · · · · · · · · · · · · · ·		·	
	OI CONTINU										•
	O2 IOJB(L						-				
150	OO CONTINI	JE									
					-						
Ç.											
	FOLG DEȚERI	TINES IN	TERPOLATE	D VALUES .						······································	
75 C											
		/-QA(IQ)		•							
	DIY=8V-									•	
		DEX(IQ)				. ,					
0.0		/DEY(IB)			•						
80	DO 301								<del></del>		
		ULK(IB,						,			
*** *** *		BULK (IB+		•	*						
		ULK(IB,									•
- në - '-			1,10+1,K}								
87				(A(K))*CX+(A	B(K)-AAIK	))+CY+CX+CY+(A	(ACK)				
	*+ DD (K)-		B(K))	***	## # 1 PD #						
301											
• •		CP (APPVA						1		······································	_ ,
20		(P (APPVA	(2))								
90	. RABJ#AI		40. 0.5					·		<del>``</del>	<b></b>
			ABJ=-RABJ	l	•					,	
ter the sist confuse eq. s		4	•			e			·		
	END										
430000 OH 6700:						-					
41000B CM STORAGE (	0250	• 666	SECONDS								

	BLOCKDATA	PLSUID	73/172 T\$			FTN 4.6+452	05/17/79	16.20.18	PAGE	1
Mira r w			•	,	 	mal # ***	the set to 12 to 4 to			
		COMMO	DATA PLSUID N/IDDATA/IDNR IDNRS(3)/3/	\$(6)	•	*** & V				***
4100	B CH'STORAGE	USED	.014 SEC	ÖNDS		4#*				
			•	•	•	•	•			×

	to the company the terms of the second of th	,
•	SUBROUTINE PHILM	
	C THIS OPTIMAL VERSION OF PHILM IS FOR ALL SCALLOPING RATES	,
E .	C AND PROVIDES A CRUDE SEARCH-AND-ACQUISITION FUNCTION	
+ ; ² , · ·-	C ACCESSED AS FOLLOWS: C SEARCH MODE: NGM=NGMIN	TO A STORY OF A CONTROL OF THE STORY OF THE
•	C ACQUISITION HODE: NGHIN.LT.NGM.LT.NGMAX	
•	C FULL TRACK MODE: NGM=NGMAX	
· 10 · ·	C	i was a state time to the
all the Administration was as	THIS NEEDS NGMIN-LE-NGM (-LE-NG) -LE-NGMAX	. The second of
	REAL LAMDA	
15	LOGICAL NOKLHN, NOLOE, NOAC, KALMAN, LOE, TETHRO	
	COMMON/RCVRO1/NGMIN,NGMAX,DELBL,NGM,IR,IAE COMMON/RCVRO2/RHOMAX,DTHO,TORO,BO,WSCO,NSO(4),NGO(4)	
	COMMON/RCVRO3/PI,F(8,8),FL25(4);FSAMP,K,KM,TETHRD,NG,NS,JM	in this was decount was notice that the same a side that it
	COMMON/RCVRO4/DELT,ED(8),GQGT(8,8),H(5,8),ICDUNT,SIGHA COMMON/RCVRO5/NOLDE,NOKLHN,NDAC,GAMAES(5),RDIAG(5),PHDIAG(8)	
20 '	COMMON/RCVR06/PPDIAG(8), RMAT(5,5), PHI(5,5), PA(8,8), LAMOA(5)	
	COMMON/RCVRC7/T(130),V(130) COMMON/RCVRO8/XSLOE(8),ESLOE(8),ES(8)	• •
,	COMMON/RCVR09/BRCVR,BB,PDCRIT,CC	
25	COMMON/RCVR10/ALFA,THES,THESDT,ALFAR,THRS,THRSDT,B,WSC,XS(8) DIMENSION INDEX(2),DT(130,5),HW(130),W(130)	
		2 MP 1 M 10 M 17 PP
	C FOLLOWING EFFECTS INITIALIZATION	
100 77 1771	IF(K.GT.0) GD TO 10	
, 30	' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' '	
*	\$\$2=.5/{\$IGHA**2}	· · · · · · · · · · · · · · · · · · ·
-	IR=2 Return	
35	10 CONTINUE	,
	C FOLLOWING PROGRAMS THE SEARCH	, , , , , , , , , , , , , , , , , , , ,
•	· · · · · · · · · · · · · · · · · · ·	er 1
40	IF (NGM.GT.NGMIN) GO TO 30 ALFAR*ALFA*RHOMAX	•
	THRSDT=TDRO	
•	MSC=MSCO	
- 1	THRS=THES=OTHO	The control of the
45	30 CONTINUE .	•
	C FOLLOWING COMPUTES CONSTANTS FOR PRESENT SCAN	
	AL2=2.*ALFA	
50	AL22=AL2*ALFA	_ '
	AR2=2.*ALFAR AR2*ALFAR AR2*AR2*ALFAR AR2*AR2*ALFAR AR2*ALFAR AR2*A	
	AAZ=ALZ*ALFAR	
55	C FOLLOWING INITIATES LOOP AND COMPUTES FUNCTIONS	
	C FOR EACH J	<u>-</u>
	Company and the company and the company of the comp	**

	208KHOLTHE SHIF	n /3/1/2 15		FIN 4.0+422	03/11/14 10:14:34	PAGE 2
	~	a see almoster at	1 T Y	141 4 44 4 4 4 4	hap and in all months of the same of	t the sections
		DO 60 JI=1,JM2		_	_	
•	• • •	INDEX(1)=JI	1 "	•	~	•
60		INDEX(2)*JMIJI	1 .		•	
		THAJ=THA(T(JI))				,
		THEE THES-THAJ	a management of the			
		PJ=P(THEE)				
,,		POJ*POOT (THEE)		- + -		
65		P2J*PJ**2				
		THER = THRS-THAJ' PRJ=P(THER)				
		PORJ=POUT(THER)				•
		PR2J=PRJ**2				
70		PPRJ=PJ*PRJ	ι			
		QNR J= .5*AL 22*P2J		•	* * * * * * * * * * * * * * * * * * *	
	•	QRJ=QNRJ+.5+AR22*PR2J				
•-•	,	D1NET=AL2*P2J	72. 2 2 7 11 11			. –
		C1*AR2*PPRJ			am 4 alb	
75		D2NET=AL22*PJ*PDJ"			, _I	
		C2=AA2*PDJ*PRJ	4		•	
		D3J*AR2*PR2J				•
٠.		C3=AL2*PPRJ D4J=AR22*PDRJ*PRJ	part is t		,	ner k s
83		C4=AA2*PJ*PDRJ		•	•	
٥٥,		O5J=-AAZ*PPRJ	40 tps   4   1	* * *		
	C FOL	G COMPLETES CALCULATION	S FOR TO, FRO SCANS, F	RESP.	•	
	1 / 100 1 1 1 1	DO 50 I=1,2	•	··· 1 ÷		•
		J=INDEX(I)				
85		BLOCAL=PVALUE(B+WSC*T(	J),3.1415927,DELBL)			
		SB*SIN(BLOCAL)				, ,, ,
		CB=CDS(BLOCAL)	•		· • • •	
		GJ=QNRJ			의 <b>의 조</b> · · · · · ·	
90		QRJALL*QRJ~D5J*CB ' 1 D1J*D1NET			් බ්	
70		D2J=D2NET	** " * * * * *		型質	,
		IF (NGN.LT.NGMAX) GO T	n 40		ORIGINAL OF POOR	•
	· · · · - · · · · · · · · · · · · · · ·	QJ=QRJALL			· Q.E	•
		D1J=D1J+C1+CB				
95	,	02J=02J+C2*CB	, • •	•	QUALCE	
	40	CONTINUE				_
•		OT(J,1)=D1J			2 %	_
,		DT(J,2)=D2J	a series agreement of the material of the state of			Ma 240 p
100		DT(J,3) = D3J+C3 * CB			20	•
100		DT(J,4)=D4J+C4*CB DTJ5=D5J*SB"		-	A. W.	
		DT(J,5)=DTJ5				
•	C FO	LG IS FOR A 6D LOE DESI	GN			•
	č	DT(J,6)=DTJ5*T(J)				
105	C FOL	LOWING COMPUTES VECTOR	HW(JK),AND INNOVATIO	S PROCESS VECTOR	W(JM)	~ ·
	C					
		"HW(J)=14/(14+24+QJ) ""		• •		•
		N1*A(1)				
		UJ=\$\$2*(UJ++2)		, ,		•
110		W(J)=(UJ/SQRT(1.+QJ*UJ	}]-1.			-
	50	CONTINUE				
	60	CONTINUE	M 4 Non 7 T 1	-	•	
	č	FOLLOWING COMPUTES VE	CTOR LAMBA(NG) AND M.	ATRICE PHI(NG.NG)	*	

SL	BROUTINE PHIL	M . 73/172 TTS T	FTN 4.6+	452	79 16.19.59 "" PAG	E 3
115	C	and a second a line of the second and a second a	I parentimental statement and resident		17/100 AND	
,		DO 110 I=1,NG				
		LAMDA(I)=0.0				
		DD 70 J=1,JM " LAMDA(I)+DT(J,I)*W(J)				
120		CONTINUE				
	, ,	DD 100 L=1,I				
****		PHILI=0.				
		DO 80 J×1,JM		,		
	*** *** ** **	PHILI=PHILI+HW(J)*DT(J,I)*DT(J,L)				
125	80	CONTINUE	•			
		PHI(L,I) =PHILI		**** *** * * *** ** *** ******		
		PHI(I,L)=PHILI			w.	
		"IF (NOLOE) GO TO 90 """ RMAT(L,I)=PHILI			,	•
130				2 2 24 42 42 44 44 4 4 4 4 4 4 4 4 4 4		
	90	CONTINUE			.'3	
	······································	'CONTINUE"	and the transfer and the second second second	erm hite amenda anggespilipi i		
	113	CONTINUE .				
		RETURN				••
135		END			•	
4100C0 C						• • •
410008	M STORAGE USE	D .805 SECONDS	and the state of t			, ,
					,	
						0 400
				7 405		
				رالانكي والسوميس بدا منسا	(	
					Ŀ	
		o PC PI - PPA 1988/18 NO 9 ARRANGO MIRANGO (April principle) A April 1981 principle and activate activ	AND THE CONTRACT OF THE PERSON AND AND ADDRESS AND ADDRESS OF THE PERSON ADDRESS OF THE PERSON AND ADDRESS OF THE PERSON ADDRESS OF THE PERSON AND ADDRESS OF THE PERSON ADDRESS OF THE PERSON AND ADDRESS OF THE PERSON ADDRESS O	حدث مقرب مدد مدد مدد المراقع المام الم المام المام ال	-	-,
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			rene o e men unum take pe e e	5 - 5 5		•
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			•	~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~	7 7 10.2	
		ا المان ا				·
	,			57.		
		*** * * * ******* * * * * * * * * * * *				

BLOCKDATA PLOPID 73/172 TS FTN 4.6+452 05/17/79 16.19.59 PAGE 1 BLOCK DATA PLOPID COMMON /IDDATA/IDNRS(6)
DATA IDNRS(3)/2/ END 

. . . .

FUNCTION PHLS	73/172 TS	" FTN 4.6+452	05/17/79 16.20.19	PAGE 1
The field and all strong-systems seems for the fields on proper to the disk of the control of th	FUNCTION PHLS(THETA)	F S Comp of species color color p or a promote and best to the state of	C   1   1   1   1   1   1   1   1   1	
, C .	THIS COMPUTES THE TRANSHITTED SIGN. THAT AT BEAM CENTER AS A FUNCTION THE MODEL GIVES FIRST SIDE LOBES 2.	OF THE ANGLE-OFF-BORESIGHT.		a
5 C		41 4 3 W W W F F		
	LOGICAL MORE COMMON/MLS004/BMLS,BBB,MTIMES,MSET, DATA PCRIT/.7853981635/,AA/1.570796		* * * * * * * * * * * * * * * * * * * *	
10	PHLS=PCRIT Z=8B8+THETA			
instances describe on the present of a describe of the describe of the described of the des	. IF (ABS(ABS(Z)-1.) .LE. 1.E-7) RETU   PMLS=(COS(AA+Z))/(1Z++2)	RN ,	1, ************************************	
· · · · · · · · · · · · · · · · · · ·	RETURN	· •••		
41000B CH STORAGÉ USE	D	,	JIM 54 55 L # L #41 W	
Mark of the state	* ** ** ** ** ** ** ** ** ** ** ** ** *			
,				
A STATE OF THE STA	والم أواب فالعا			

BLOCKDATA PM	MLS10 73/172 TS		FTN 4.6+452	05/17/79	L6.20.19 PAGE	1
	BLOCK DATA PMLSID COMMON/IDDATA/IDNRS(6) DATA IDNRS(2)/1/ END					
41000B CH STORAGE U	USED .016 SECONDS		H 400 % 6.1 F	,	,	
~			11.0	F is any part and the second to the	d an lang management of the state of the sta	
2 m/ 4 m/ 4 m/			•		1	
	The second secon	out of the parties are not the		/ to tend we aske		
	* n			• -•	7 mm 1 11 mm 11 mm 11 mm 1 mm 1 mm 1 mm	***
			k	a		
and deligated the second of th	3 A AP 40 M 2 H P 4 W 4 4 H		• • • •	>		
A 200 UAN U P 4	• • •					•
_, , , ,,, ,, ,, ,,, ,,, ,,, ,,, ,,,,,,,	•	-	, ,		annument a manus es unir es a	
	•	•		. , , , , , , , , , , , , , , , , , , ,		
<b>.</b>	•					
gegy t		• •		, ,,		, -, ,
#FA # 1 # # * * *	y d y th I week a	·	<b>4</b>	n terminario		
<b>.</b>	•		უ 🛱	r -		· · · · · · · · · · · · · · · · · · ·
<u>.</u>	•		DE POOR		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
			70 T	, ,, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		
· .			QL PA	•		
<u>.</u>		,	P. H			
-	•	<b>'.</b>	PAGE IŞ QUALITY	, 4111		
-					•	

FUNCTION P	73/172 TS	, - и - 4	FTN 4.6+452	05/17/79	16.20.23	PAGE	1
	FUNCTION P(THETA)	RANSMITTED SIGNAL INT	ENSITY (RELATIVE TO		.,		
' C , _		AS A FUNCTION OF THE		. ,			
C	THE MODEL GIVES FIR	RST SIDE LOBES 23 DB B	ELOW THE MAIN LOBE.				
5,5,	-,				<del></del>	<u> </u>	
	COMMON/RCVR09/BRCVR	BB, POCRIT, CC		•			
	DATA PCRIT/.78539816	535/.AA/1.570796327/					
7 701 7 101 10 10	P=PCRIT		, , , , , , , , , , , , , , , , , , , ,	, Line wear	· · · · · · · · · · · · · · · · · · ·		
	Z×8B+THETA				•		
10	IF (ABS(ABS(Z)-1.)	LE. 1.E-7) RETURN	•				
	P=(CDS(AA+Z))/(1Z*	· + 2 }					
	RETURN						
	END						
	(			•			
/***** AH ****** AF ***	(0/0 0505)						
41000B CM STORAGE US	FD	4D\$					

FUNCTION POOT	73/172	TS .	•	FTN 4.6+4	52 . 0	5/17/79	16.20.23	PAGE	1
	m ames 24 4(p vs 1 50; vs 4 54		ms 44 Ms =						
C	FUNCTION POOT			,	425 (3 see) ye	\ -	p- ux (a manua x y y y		
. C , ,.	IS THE TRANSM	ITTED SIGNAL I	NTENSITY (RELA	THETA WHERE P(' Tiye to that a	T BEAM				
5	. CENTER) AND TO	HETA IS THE AN G FIRST SIDE L	GLE-OFF-BORES OBES 23 DB BE	IGHT.THE P-MODE LOW THE HAIN L	EL USED OBE•	A 400 410000			
C	COMMON/RCVR09/	BRCVR, BB, PDCRI	T,CC '	<b>1</b>					
10 · · · · · · ·	DATA AA/1.5707	96327/		•					
	PDOT=SIGN(POCR Z=88+THETA	IT,-THETA)	,	salmes months	70.1-1-4				<del></del>
	1F (ABS(ABS(Z)- CP=AA*(Z+1.)	-1.) .LE. 1.E-	7) RETURN						
15	CM=AA+(Z-1.) PDDT=CC+((CDS()	CP)-SIN(CP)/CP	)/CP+(COS(CM)	-SIN(CM)/CM)/C	M)				
Way bette of the draw will take with t	RETURN END	, , , -	A		e ment 1 e				
41000B CH STORAGE USE	.119	SECONOS		•	•	· -			

ORIGINAL PAGE IS

BLOCKDATA POPT	ID 73/172 TS	FTN	4.6+452	05/17/79	16.20.23	PAGE	1
		/ mass			<u> </u>	· · · · · · · · · · · · · · · · · · ·	
	BLOCK DATA POPTIO CGMMON/IDDATA/IDNRS(6) DATA IDNRS(6)/I/ END.						· · · · · ·
41000B CH STORAGE USE	0o13 SECONDS,				······································		

SUBROUTIN	NE RCVR 73/172 TS	FTN 4.6+452	05/17/79	16.19.09 PA	AGE 1
1 of sector and describe actions are the	and the same and the same and the same of				
	SUBROUTINE RCVR				
	C THRESHOLD RECEIVER	,,,,,		** 15 = =	** *
	REAL LANDA				
	LOGICAL NUKLHN, NOLDE, NOAC, KALMAN, LOE, TET	HRD ' - '- '		• • • • • • • • • • • • • • • • • • • •	
	COMMON/RCVROO/THAMAX,THAMIN,TS,TR,OMEGA,	TF			
•	COMMON/RCVRO1/NGHIN, NGMAX, DELBL, NGM, IR, II	AE			
	COMMON/RCVRO2/RHOMAX, DTHO, TDRO, BO, WSCO, NS	SO(4),NGO(4)			
	COMMON/RCVRO3/PI,F(8,8),FL25(4),FSAMP,K,	KK,TETHRD,NG,NS,JH	• • • • • •	*	•
	COMMON/RCVR04/DELT, ED(8), GOGT(8,8), H(5,8)	),ICOUNT,SIGHA		•	,
10	COMMON/RCVRO5/NOLOE; NOKLMN, NOAC, GAMAES (5)	),RDIAG(5),PMDIAG(8:	) '''' '''' -	***************************************	
	CUMMUN/RCVRO6/PPDIAG(8),RMAT(5,5),PHI(5,5)	5) PA(8,8) LAMDA (5)			
	COMMON/RCVRO7/T(130),V(130)	•			
	COMMON/RCVROB/XSLOE(B), ESLOE(B), ES(B)				
1.5	COMMON/RCVRO9/BRCVR, BB, POCRIT, CC		' '		
15	COMMON/RCVR10/XS1(8),XS(8)				
	DIMENSION VPK(2), VTH(2), N(2), U(130), W(130	D), TRG(2)			
	DATA GX/100./	7 71 11 1 11 11 1			
	15 (V 07 0) 00 TO 00				
	IF (K .GT. 0) GO TO 50			•	
20	C'FOLG IS INITIALIZATION '	- , , , , ,	·		
	IRel				
,	NS*NSO(IR)			, , , , ,	
	NG=NGD(IR)				
25	CALL CONTRU (3)				
·/ ·	DM&GA*-200004 JM2*JM/2	-mu			
	JM22=(JM2+1)/2				
	T TSAMP=1./FSAMP				
	JDELAY=IFIX(2.*3.1415927*25000.*TSAMP+.5)				
- 30	JM22*JM22+JDELAY			,	
**	ICOUNT = 0				
	XS1(3) *0.0/mi ====================================	***		-	
	XS(3)=0.0				• •
	CALL CONTRET (4)			****	
35	RETURN				,
	" 50 TT CONTINUE				
	C ,				
	C FOLG PRODUCES TG1 AND TG2 ' "	•			
	TPST=(XS1(2)-THAMAX)/OHEGA				
4.13			., . ,		
41)	1PSF = 1F + (IHANIN-XS1(2)) / OHEGA				
	(				
	C FOLG PRODUCES LOG ENVELOPE SIGNAL FILTERED TO	3 29 KHZ			
	DO 70 L=1,2				
- , -	VPEAK=0.0			1	
45	00 60 J#1, JM2		•		,
	[]#]+([-])#]WS ,				
-	JM21*JM2+1			*** * * **	
	U(I1)=20.0*ALDG10(1.+GX*V(I1))				
	IF((I1.Eq.1).OR.(I1.Eq.JM21)) FL25(4)=0.			•	
50	CALL DFLTR1(U(I1),W(I1),FL25)" ' '				
	VPEAK * AMAX1 (VPEAK, W(II))			•	
	60 - CONTINUE ' '- '- '- '- '-	•			
,	VPK(L) = VPEAK				
	VTH(L)=VPEAK-3.				
55	70 CONTINUE			-	
•	'- IF(K:NE.1) 'GO TO 80'	-	•	•	
	NABORT = 0			•	

THDRVR Page 1 of 4

" " SUBROUT INE ROVE	73/172 TS FTN 4.6+452 05/17/79 16.19.09 PAGE 2
	NNOM=1+IFIX(2.*5.0E-5/TSAMP+.5)
	N(1)=NROM
60 -	N(2)=NNOM '
80	CONTINUE
	00 140 I=1,2
	JJ=JM22-N(1)/2
	N2=(N(I)+1)/2
65****	DJ*(N2-1)*TSAMP
-1	TG1=TPST=OJ
	TGZ=TPSF=DJ
	TAUSTIXTG1
70	TF(I.EO.2) TAUSTT=TG2 VT=VTH(I)
	J0*(I+1)*JM2+JJ
	J1=J0+N(I)=2 ·
*** *** *	L=1
	ISIGN=1
75	DO 100 J*J0,J1
	V0=W(J)
,	V1=W(J+1)
	TAU:TAUSTT+(J-J0,)+TSAMP
	DELTAV=(VI-VT)+ISIGN
80	IF(DELTAV.LT.C.O) GD TO 100
	TDWELL=TAU+TSAMP*((VT-VO)/(V1-VO))
	IF(J.NE.JO) GD TD 90
	IF(VO.GT.VT) TDWELL=TAU
90	IF(L.EQ.2) GD TO 130
69	L=2
	TOWELL TOWELL
100	CONTINUE
	TF(L.EQ.1) GO TO 190
90	1DWELL = TAU+TSAMP
130	CONTINUE
	GWIOTH=TDWELL-TDWEL1
	`IF((GWIDTH-LT-15-E-6).OR-(GWIDTH-GT-350-E-6)) GO TO 190
	TRG(I)=2:#GWIDTH
. 795	TC-(TOWELL+TDWELL)/2.
	IF(I.E9.2) GO TO 150
1/4	TC1=TC
140	CONTINUE TELTETETCT
	DDD*(*5E-6)*IFIX(DELTET/*5E-6+*5)
100	XS1(2)*(-DMEGA/2.)*(DDD-TR)
	XS(2)=XS1(2)
10 70 7 700 00 00 00 00	XS1(1) * (VPK(1) + VPK(2)) // 2.
,	XS1(1)=(10.++(XS1(1)/20.)-1.)/GX
105	XS(1) + XS1(1)
	DO 160 1=1,2
	RG=TRG(I)/TSAMP
	N(I)=1+2*IFIX(RG/2.+.5)
160	CONTINUE
110	NABORT=0
	RETURN
190	
	NABORT-NABORT+1

•	SUBROUTINE	RCVR	73/172	TS	•	•	FTN 4.6+452	05/17/79 16.19.09	PAGE 3
helm madespele that a manager to			T & w m Fren						· · · · · · · · · · · · · · · · · · ·
115			N(1)=NNOM	. ,	*		, .		
			N(2)*NNOM X5(2)*XS1(2)		r			• •	
	•		RETURN				•		•
			END						
41000	B CM STORAGI	e use	0 .822	SECONDS					

BLOCKDATA TRVKID 73/172 TS FTN 4.6+452

05/17/79 16.19.09

BLOCK DATA TRVRID COMMON/IDDATA/IDNRS(6) DATA IDNRS(3), IDNRS(4), IDNRS(6) /1,1,0/ END

410008 CM STORAGE USED - .023 SECONDS

THDRVR Page 4 of 4

A-91

P1	ROGRAM ACOM	IP1 73	/172 T	s		FTN 4.6	5+452	05/17/79	16.20.50	PAGE	1
		PROGRAM	ACQMP1(	INPUT, OUTPUT	TAPE10=INPU	T, TAPE15, TAPE7	7=0UTPUT,				u
		*TAPE20)									
•		INTEGER									
						R(100), ERTHTR(					
5						5), NAME (10), NA					
					(4), TIM(102),	TOTAL (100,5),Y	LEKKOK (2)				
		DIMENSIO			ALL 400405 N		**				
					LO)),(RNAME,N		7111				
					TAL (1,4), ERTH	AL(1,2),ERTHTA		·· · · · · · · · · · · · · · · · · · ·			
10		*(TOTAL()			IAL (1) 4/) EKIN	IKCLIII				_	
		DATA NAM	F1/10HS	IN. JOSE -34	11H .10H FTLE	No: ,3*1H ,10	OH DÁTE:				
	•	*1# /	C1710110	2111 0001 72	AII 74011 1 422	, , , , , , , , , , , , , , , , , , , ,	24.72.	•			
-			E2/10HP	LOT JOB: •34	H .10H PROG	RAM: ,10HACQMP	2*1H	,			
. 15			ATE: +1		,			·			
					DR/14.,11.,8.	,5.,2./,5/.12/	/•H/•07/				
		, DATA NAM	TIM/10H	TIME SINCE, 1	LOH START OF	,10HFIRST SCAN	N. LOH (SECO	NDS	·		
		*)/, IBLAN	K/2H /						Į.		
					0/,YMMAX/1./						
20						10HES ALFR ER	₹,				
				OHALFAR/ALFA							
		CALL CAL				•					
	·	CALL FAC				- ,					
25	^	CALL PLO	11+2.0)	1.0)-31							
23	C 0111	JOBNAME	AND DAT	E IN APPROPR	RIATE ARRAY E	LEMENTS.					
	č	OUGHAIL	AILO DAI	L 2M ATT NOT		CENERIO					
		NAME2(2)	-JOBNAM	E(A)	420 44 7				· · · · · · · · · · · · · · · · · · ·		
•		_RNAME2=D									
30 " " "	`				, ",,,,,,,,		,				
• •	C REA	D NUMBER	OF FILE	S TO BE PLOT	TTED.			-			-
	С										•
		READ(10,	10) NPL	OTS	. ,						
	10	FDRMAT(I	2)								
,_35						05 4405	· • •				.,
	C WRI	TE JORNAM	E, DAIE	, AND NUMBER	R OF PLOTS TO	BE NAVE.					
			201 NAM	E2(2),RNAME2	- NDI DTC						•
	20					10//1X,I2,20H	ETLES TO B	E D			
	20	*LOTTED)	OUTOON	Anty, JAIO912	A CHIDATE SA	10,,11,12,2011	, 1669 (0.0	• '			
10	с										
	C****	******	*****30	O' LOOP TO P	LÔT EACH FIL	E					
	Ċ										
5		DO 300 N	=1,NPLD	TS	-						
45	_							* / = = =			
•	C+++4	******	******	*******	****						
	C+	READ DATA	FROM D	ISK, WRITE C	ON LPR *	• •	, ,,				
	C****	*******	****	******	+++++++						
	C			*************	OT NUMBER AN	A ETIC NAME					
50	C REA	AU CURKENT	FILE N	AUGIAKTIE LI	LOT NUMBER AN	O FILE NAME.					
	٠,	READ(10,	201 017	INTO)		-		41-10 7			
	an'	FORMATIA	10)	10121		1					
	_ 3V	WRITE(7	401 (04	TIN(I), I=1,2	21.N.NPLOTS	*1 *1	•				
55	40					12,4H DF .1	12/)				
22	٠, ٧٠			PE15 DATIN)				,			•• •
		IF (IR.FO									

PROGR	AM ACOMP1	73/172 TS		FTN 4.6+452	. 0	5/17/79	16.20.50	PAGE	2
60	50 FORMA STOP	E (7,50) AT (20H FILE DID ) INPUT FILE ATTAC		₹ <b>∀</b>			**************************************		
	C READ DATA	A FROM DISK AND P	LACE IN PROPER LO	CATION OR ARRAY.					
65	READ: READ: C********	(15) DOUT, DELT, HT. (15) (IDENTS(I), I (15) NRUN, OSNRDB, RI *********	■1,6),KSTART						
70	READ 70 CONT READ CALL DECOI	INUE	TDRO, BETAO, FSCO, 1 N1, IRCVR, NN2, NN3;	),ERTHTR(K),X4TOX1(K EBETAO,EBETAH,EFSCO, NN4		, , , , , , , , , , , , , , , , , , ,			
75	C WRITE DA	TA READ FROM DISK	ON THE LINEPRIN	TER.					
80	C WRIT 80 FORM	E(7,80) DOUT, DELT AT (1H ,A10,8X,G1 E(7,90) IDENTS,KS	, MTIMES, LGMAX, KM, 3.6,5X,3(5X,13,1)	TODAY, JBNAH	** * '	( me a asblace so		*	
	WRIT 100 FORM C	AT(1H ,2X,12,4X,7	NROB,RHO,BETA,FS( (2X,G13.6)/)	C, BMLS, BRCVR, THESEP			~		
85	C WRITE FI	RST 35 VALUES, 5	PERIODS, THEN TH	E LAST 3.	<del>.</del> .			r gymyd gygynia alba. M	
90	. DO 1 WRIT 110 FORM 120 CONT					, ,	<b>5</b>	··· · · · ·	
** *	DO 1 WRIT	*********140 . 40 K=1,5 E(7,130)	• • •		•	، د محي پنده •		, mar 1	
95	140 · CGNT		1X))						
	_	KN-3 +********150 50 K=KM3,KM	•		•		4 fr a 7 pm = 4-	u	
100	WRIT 150 CONT WRITE 151 FORM	E(7,110) (TOTAL(K INUE	HO,TDRO,BETAO,FS	CO, EBETAO, EBETAH, EFS	CO, EFSCH		a a w a bawan		
105	C# PLOTT	**************************************	*	·		** •			
	C	T EDGE OF THE PAG	_	-			. ,,, , ,	ngai.	
110	_ C CALL CALL	PLOT(-2.0,0.0,3) PLOT(-2.0,7.0,2) LE AND PLOT INFOR	marampha as my y as again an	PAGE.	* • •			ura.	

•	PROGRA	M ACQMP	1 73/172 ·TS		FTN 4.6+45	2 05/	17/79 16.20.50	PAGE	3
11	£ , .	^		, .,	, ,				
11	,	·	XH=5		•		1444 - Marie A 1- 1944		~ ~ -
			YH=8.7-S	•					-
			CALL SYMBOL(XH, YH, F	1,NAME1,0.0,90).					
12			************160. DO 160 I*1,10					···································	
12	U		NAME(I)=IBLANK						
	•		CONTINUE	, ,	•				
			NAME(2)=JBNAM		•	1 87 5			
12	6		DECODE(10,170,DBUT) FORMAT(A10)	NAME(6)					
:			RNAME = TODAY				· · · · · · · · · · · · · · · · · · ·		
			CALL SYNBOL (XH, YH, F	1, NAME, 0.0, 100)		44 **		,	
			YH=YH-2.+S						
. 13	n	٠	CALL SYMBOL(XH, YH, F	1, NAME 2, U . U , I U U ]	•	, an market 4 m			
		Č WRI	TE PLOT INFÖRHATION	ON BOTTOM OF PA	GE			•	
		C			,		ľ	¥.	
					2), BHLS, DELT, KH, KSTAR				
13	5		FORMAT(11HSCENARIU) F9.7,9H SEC, KM=,13		BMLS=,F4.1,11H DEG,	DEE1=,			
			YH=S	2/ 111/ NOTAKI-715/	•		· ·······		
			CALL SYMBOL (XH, YH, F						
			ENCODE(81,230,NAME)						
14	0		FORMAT(9H S/N=; 10H DEG;FSC=;F8.3;1		,F5.1,7H, BETA*,F6.1, 6.3.4H DEG)	•		:	
'			YH=0.0						
•	, , ,		CALL SYMBOL (XH.YH.						
	'		ENCODE (59, 250, NAME )		6),BRCVR ,A8,1H,,A6,8H, BRCVR				
14	5		F4.1,4H DEG)	, , 4 ( ) 2 ( ) , 4 ( ) 2 ( )	AND THE SKY OF BREAK	-,			
	-		YH=-S	•		-	_(Q);		
			CALL SYMBOL (XH, YH,			• • -			
			IF (IRCVR.NE.2) GO ENCODE(83,255,NAME)						
15	ó ` -′				IDLER VALUES: F4.1,1	H, , i i i			
			F4.1,5H DEG,,F4.1,9	H DEG/SEC, F5.1, 5	H DEG,,F4.1,3H HZ)				
			YH=+2*S	U NAME & & 681			70 -		
-			CALL SYMBOL (XH,YH; ENCODE(64,256,NAME)		• •		O		
15	5				INITIAL=,G10.3,7H,FI	NAL=+G10.3	Q C		,
**			,3HDEG)					A.	
-			YH=-3.*S CALL SYMBOL (XH,YH,		•		<b>2</b>	P	
			ENCODE(63,257,NAME)				188		
16	.0				INITIAL=,G10.3,7H,FI	NAL=,G10.3			
			2HhZ}			3 2 15 m No. 40 40 40 40 40			
			YH=-4.*S CALL SYMBOL (XH,YH,	.U.NAME.O.O.421					
			CONTINUE	OF NAMES OF US OF	•	•			
16	5		XH=0.0		** ,				
		•	CALL FACTOR(.5)		•				
		C FILI	ARPAY WITH HORIZON	TAL AXIS DATA					• •
		c			•				
17	0 '	C++++	*************260 DD 260 K=1,KM	•					

	PROGRAM	ACOMP1	73/172	TS		FTH	N 4.6+452	05/1	7/79	16.20.50	PAGE	4
		T1M()	<)=DELT+(	K-1)	•	•	•		•	N 4-		
175		C++++++++	******	M.ALX.KH. 290: LOOP	1) FOR 5 PLOTS.							
140	` ""	AMAX: AMIN: ********	90 L=1,5 =+1.E+320 =1.E+320 +*****			٠ , ,,	\( \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \					
180	•	C	70 K=1,KM		as b.s.	• •		•				
**** ***		C.FIND HIN	AND MAX	OF ERROR	DATA.		) m ( m )		<del></del>		·	
185	٠,	270 CONT	≈AMAX1(TO INU€	TAL(K,L), TAL(K,L), Š(AMAX),A	AMAX)	•		,	-			 
190		YMIN: If(L	YMAX -EQ. 5} -(YMAX-YM	YHIN=O,	** * *	•		•	- •	,	1	
		C FILL ARR	AY WITH E	RROR DATA	INCLUDING YMIN	AND YINC.			•	in the		
195	-	DO 2	******** 80 K=1,KM }=TDTAL(K						- <b></b>		<u>^</u>	
.200	,	280 CUNT YY(K			•		•	•				
		C DRAW Y-A		RITE LABE	L•		- 1,				. 4	
205		YHM= Call		YH, LABELS	(L),10,ALY,90.0	O,YMIN,YINC)				· 	<u>``</u>	٠.,
		C MAKE PLO	F OF ERRO	R DATA.			•	• • • • • • • • • • • • • • • • • • • •			***************************************	
210		CALL	PLOT(0.0	, YY, KM, 1,	0,0)				,	-th year bear lab year of		
215		C		XIS FOR A	LL 5 PLOTS.				,			
		CALL	AXIS(XH)	YH, NAKTIM	,-40,ALX,0.0,T	IH(KH+1),TIH	(KH+2))			•	,	•
,	- •	C 5 PLOTS	FOR THE F	ILE ARE N	OW COMPLETED			·				
220		CALL	FACTOR(1	• )								
		C RESET OR	IGIN AT	B.5 INCHE	S ALDNG X-AXIS							
2,25	,	CALL 300 CONT	PLOT(0.5 Inue	,0.0,-3)	•	-				e chief has been more.		
		C DRAW RIG	HT EDGE O	F FINAL P	LOT.							

PROGRAM AC	COMP1 73/172 TS	FTN 4.6+452	2 05/17/79 16.20.50 PAGE 5
		**	And I on I to known whether the standard and described deliction of the standard described descr
230 .	CALL PLOT(-2.0,0.0,3) CALL PLOT(-2.0,7.0,2)	• •	
•	, CALL ENDPLT STOP		
٧	_ END /,,	y a summy plant of the set of the	. /
42000B CM STORAGE U	JSED 2.817 SECONDS	r rain management to the TA	, 250 km a massa <del>a </del> massa <del>a massa massa massa massa massa a massa massa massa massa da massa massa da massa massa massa da massa </del>



SUBROUTINE CLIP(A,KM,AMAX,AMIN,ISW,KC)  DIHENSION A(KH)  LOGICAL LA,LE  C  S  C  LA=,FALSE.  LE=,FALSE.  LSW=0  OD 100 KK=1,KH  K=KKH=1-KK  IF(A(K),GE,AMIN) GO TO 10  LE=,TRUE.  A(K)=AMIN  IF(ISW=EQ=0) ISW=-K  GD TO 20  IF(LISW=NE=0).AND.(KC,EQ=KM)) KC=K  20 IF(A(K)=LE-AMAX) GO TO 30  A(K)=AMAX	SUBROUTINE CL	.IP " 73/172 TS	• -	" FTN 4.6+45	05/18/79	13.53.08	PAGE	1
DIHENSION A(KM)   LOGICAL LA, LE		SUBROUTINE CLIP(A,K	M. AMAX. AMIN. ISW. KC)				,	
C								
C		LOGICAL LA, LE	,		•			
LA.FALSE. LE=.FALSE.  15W=0  0D 100 KK=1,KH  KKH+1-KK  IF(A(K).GE.AMIN) GD TD 10  LE=.TRUE.  A(K)=AMIN  IF(ISM.EQ.O) ISW=-K  15	· · · · · · · · · · · · · · · · · · ·	• •		• •	M41 M4 4 M444 - 4 4 F		• •	
LE=.FALSE. ISW=0  00 100 KK=1,KM  K=KH+1-KK  IF (4(K).GE.AMIN) GD TD 10  LE=.TRUE.  A(K)=AMIN  IF (ISW-EQ.0) ISW=-K  GD TD 20  IF ((ISW-NE.0).AND.(KC.EQ.KM)) KC=K  20 IF (AIK).LE.AMAX) GD TD 30  A(K)=AMAX  20 A(K)=AMAX  20 IF (LE).GD TD 100  IF (ISW-EQ.0) ISW=K  GD TD 100  IF ((ISW-NE.0).AND.(KC.EQ.KM)) KC=K  25 100 CONTINUE  END	5	KC=KM				•		
ISW=0		LA** FALSE*			***************************************			
00 100 KK=1,KH  10					•			
10								٠,
IF(A(K).GE.AMIN) GO TO 10  LE**TRUE.*  A(K)=AMIN  IF(ISW.EQ.O) ISW=-K  GO TO 20  IF(LA) GO TO 20  IF(ISW.BE.O).AND.(KC.EQ.KM)) KC=K  20						,		
LE=.TRUE.	10							•
A(K)=AMIN			TO 10				·	
IF(ISW.EQ.O) ISW=-K GD TO 20 IF(LA) GD TO 20 IF((ISW.NE.O).AND.(KC.EQ.KM)) KC=K  20					*** *** *** *** *** *** *** *** *** **			
15								
10				• •				
IF((ISW.NE.0).AND.(KC.EQ.KM)) KC=K  20	<del>-</del> -				•			
20	10		· · · · · · · · · · · · · · · · · · ·	1 wm + + 1			•	• • •
20								
20	20		1 TO 30 ' ' '					., .
IF(ISW.EQ.O) ISW=K  GD TO 100  30	••							
GD TD 100  30	20 -				•	-		
30 IF(LE) GO TO 100  IF((ISW-NE-0)-AND-(KC-EQ-KH)) KC=K			•					
IF((ISW-NE-0)-AND-(KC-EQ-KM)) KC=K 25 100 CONTINUE END	,		• , •		•	/		
25 100 CONTINUE	30							
END TO THE TAX TO THE	55		KC • Eq • KM ) } KC = K				4 °	
ENU				•				
ALAMAN AN ATOMAN MARA		END			* * * * * * * * * * * * * * * * * * * *		<b>5</b>	
	/10000 AM ATERIAN I	1000		•	•		_	

<del>,</del>	FUNCTION	GAUS	73/172	TS		' FTN 4.6+452	05/18/79	13.53.08	' PAGE	1
	• • • • • • • • • • • • • • • • • • • •		FUNCTION GAUSS	.,		, marks - 21.4 - (каришан - арки 1				
	(	• •	, oncizon oxos:	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		_				
	i		GAUSE PRODUCES	S INDEPEND	ENT PSEUDO-RANDOM	NUMBERS DISTRIBUTED				
	' `	,	NORMALLY (0.1)	BY THE D	IRECT METHOD DESC	RIBED IN THE FOLLOWING	•			-
5	(	:	REFERENCES			Manage and the Concontin	•			
• • • •	` - (			. A.STEGUN	. HANDBOOK OF MATH	EMATICAL FUNCTIONS				
	Ċ	;	APPLIED MATHER	MATIC SERI	ES#55.NATIONAL BU	REAU OF STANDARD, U.S	_			
• • ••••		; • •	DEPT OF COMMER	RCE.NOV. 19	70.PAGE-953.					4
	(	:	THIS VERSION O	OF GAUSS T	AKES INDEPENDENT	PSEUDO-RANDOM NUMBERS		•,		
10	(	3	UNIFORMALLY DI	ESRIBUTED	DN (0.1) FROM THE	COC-SUPPLIED FUNCTION		•	•	
	(	;	SUBPROGRAM RAM	VE(X).			•			
	-, -,		LOGICAL HAS			4.15 P. 484 P. 45 P.	+- /			
			DATA HAS/.FALS	SE•/						
			IF (DUHHY.EQ.O.	(C) GD TO	30 " ' "					
15			CALL RANSET(0)	}	•					
	~-		HASFALSE.							
	3	30	CONTINUE							
	,	* *	IF (HAS) GD TO	40		Phum d ym 4 4 4	* ' '* *		••	•
			X=SQRT(-2.+ALC	G (RANF (1.	0)))			i		
20			T=6.283185308#	RANF(1.)		•	,		•	
			SAVED=X+SIN(T)							
			GAUSS=X+COS(T)				** * * * * * * * * * * * * * * * * * * *	• • •		
			HAS=.TRUE.							
-		****	RETURN	•• • • • •			1 / 1 / 2 / 1   2   2			
25	4	0	GAUSS=SAVED							
	. ••		HAS= . FALSE . "				7.			
			RETURN							
;			END	, ,.			1	,		
41000B	CH STORAGE	USEC		SECONDS			94	ORIGINAL OF POOR	,	
		-						(G)	•	
								2.5		
		-	,, -,					Q <b>5</b>	,	
					ı			9,7	•	•
						•				
						•		QUALIT	-	
						4		7		
<b></b> -			<del></del>		•		•	70 8	ii.	
								E'	,	
								A	12.	

	" SUBROUTIN	E FOCI	0 "'" 73/172 "TS			" FTN 4.6+452"	05/18/79	13.53.08	PAGE	1
				1						
			SUBROUTINE LOGIO (		)					/ ##P =
			LOGICAL VALUE, VALE		2 100 2 20 11		, ,			
			INTEGER SWITCH, SLAS	SH, SYMBOL			•			
	** *		DATA SLASH/1H//			2 Un 7	, .			• • • • • • • • • • • • • • • • • • • •
	5		IF (IZ) 1,2,3							
,		- 1	READ (10,10) VALUE	, ,,,, ,,						
		10	FORMAT (L5)							
			'WRITE(7,20) VALUE'	. ,		-,			-,	
		20	FORMAT(1H ,15/)							
1	lo	• •	RETURN	" * '						
		2	WRITE (7,30) SYMBO							
		-30	"FORMAT(1H , A6, 3H =							,
			READ (10,40) SWITCH	H.VAL2						
• - • -		-40	FORMAT (A1,L5) 1	•••						•
	<b>L</b> 5		IF (SWITCH .EQ. SLA	ASH) GO TO 60						
		*	WRITE(7,50)			-1- 141 = -		144 W NO 1 3AM		-
		50	FORMAT(1H )							
*******			RETURN '							
		60	VALUE=VAL2					*		
	20	• •	WRITE(7,70) SLASH,	VALUE " "'						
		70	FORMAT(1H+,14X,A1,1	L5/)					•	
			RETURN -		- /1					
		3	WRITE (7,80) SYHBOI							
	,	80	~FORMAT (1H~, 46, 3H	<b>=',</b> L5/) ~~~ `						
	25		RETURN							
		•	END			- · · · -		• •		

- 41000B CM-STORAGE USED --- - -- - 104 SECONDS

ORIGINAL PAGE IS

- ,	SUBROUTINE	I TAH E	N 73/1	72 TS	•		T FTN	4.6+452		05/18/79	13.5	3.08	PAGE	1	
			CHOROUTINE	· ··	YMBOL,A,H1,N1.	. K1									
					1 HOOF SKALLTAGE	* * 11 *	•	-	, ,			"		•	
			IS INPUTS A Vraheters as												
					R ALPHANUMERI	C EG	* A*	- •	-		•	4	• •		
.,			IS THE ARRA		K ACTIANONENI	C)) LUI									
	<b>)</b>	L A	170 NA. 18E	THE DIME	NSIONS OF THE	'OESTRED	MATRIX		*****						
		C DI	L AND NI AKE	NU LENGTH	OF THE ARRAY	STOPAGE	115111411								
		L n	DIMENSION		DE TUE WEVEL	310000							1	~	
			INTEGER SY												
	10		- WRITE (7,5		M1.N1~						<del></del>			–	
	10	E	CODMAT/141	INTROLLY	TRIX , 46,2H (	. T2.3H Y	.12.10H	BY ROWS:)	)						
			DO 30 I=1		inty Novemen										
			READ (10,)		11 - 1 = 1 - N7 1										
_		10 -	- FORMAT(10)												٠,
•		10	WRITE(7,20	. 0134077	L. I=1 -N11										
	15	- 24 -	FORMAT(1H							4807				•	
		20 -	CONTINUE	120101310	,,,,										
		30													-
			RETURN (**) END												
			Eun					• •			'		•		
	CU CTOO!			.118 SEC	nnn ¢ .								•		
410	DOOB CH STORA	(0 E 02	EV		A IN A MI AMA A A A A A A A A A A A A A A A				-	- ,		107 100 1	•••		
•															

SUBROUTINE MATHUL(NRANDRANDRANDRANDRANDRANDRANDRANDRANDRAN	- su	BROUTINE HATH	UL " 73/172	TS .	•	* FTN 4	6+452	05/18/79	13.53.08	PAGE
**************************************		,	SUBROUTINE MA	ATHUL (NRA - N2RA	NCA, NRB, N2RB	NCB NRC		•		to become pure as the last of the contraction to the last of the l
S			*NCC, A, B, C, L)		'	•				
5 101 IF(NCA.NE.NZRB) GD TD 1000			GO TO (101-10	1KAJNGAJJB[NKBJ 12.103.1041.[	HCB1+CINKC+N	cc"				
DU 200 1=1,N2CB  C(1,J)=0. C(1,J)=0. DU 200 K=1,NCA C(1,J)=C(1,J)+A(1,K)+B(K,J)  200 CONTINUE  RETURN  102 IF(N2RA.NE.N2RB) GO TO 1000 DO 400 I=1,NCA C(1,J)=0. DO 400 K=1,N2CA C(1,J)=C(1,J)+A(K,I)+B(K,J)  400 CONTINUE  C(1,J)=C(1,J)+A(K,I)+B(K,J)  C(1,J)=C(1,J)+A(I,K)+B(J,K)  C(1,J)=C(1,J)+A(I,K)+B(J,K)  C(1,J)=C(1,J)+A(I,K)+B(J,K)  C(1,J)=C(1,J)+A(I,K)+B(J,K)  C(1,J)=C(1,J)+A(I,K)+B(J,K)  C(1,J)=C(1,J)+A(I,K)+B(J,K)  DO 800 I=1,NCA C(1,J)=C(1,J)+A(I,K)+B(J,K)  C(1,J)=C(1,J)+A(I,K)+B(J,K)  DO 800 I=1,NCA C(1,J)=C(1,J)+A(I,K)+B(J,K)  C(1,J)=C(1,J)+A(I,K)+B(J,K)  C(1,J)=C(1,J)+A(I,K)+B(J,K)  C(1,J)=C(1,J)+A(I,K)+B(J,K)  DO 800 I=1,NCA C(1,J)=C(1,J)+A(I,K)+B(J,K)  C(1,J)=C(1,J)+A(I,K)+B(J,K)  DO 800 I=1,NCA C(1,J)=C(1,J)+A(I,K)+B(J,K)  C(1,J)=C(1,J)+A(I,K)+B(J,K)  C(1,J)=C(1,J)+A(I,K)+B(J,K)  DO 800 N=1,NCA C(1,J)=C(1,J)+A(I,K)+B(J,K)  C(1,J)=C(1,J	5	101								
C(I,J)=0.  DO 200 K=1,NCA  C(I,J)=C(I,J)+A(I,K)+B(K,J)  200 CONTINUE  RETURN  102 IF(N2RA.NE.N2RB) GD TD 1000  DO 400 I=1,NCA  DO 400 I=1,NCA  C(I,J)=0.  DO 400 I=1,NCA  C(I,J)=C(I,J)+A(K,I)+B(K,J)  20 RETURN  103 IF(NCA.NE.NCB) GD TD 1000  DO 600 I=1,NCRA  DO 600 I=1,NCRA  DO 600 J=1,NCRB  C(I,J)=0.  25 DO 600 K=1,NCA  C(I,J)=C(I,J)+A(I,K)+B(J,K)  600 CONTINUE  RETURN  104 IF(NCRA.NE.NCB) GD TD 1000  30 DO 800 I=1,NCA  DO 800 J=1,NCRB  C(I,J)=C(I,J)+A(I,K)+B(J,K)  C(I,J)=C(I,J)+A(I,K)+B(I,K)  C(I,J)=C(I,J)+A(I,K)+B(I,K)+B(I,K)  C(I,J)=C(I,J)+A(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,K)+B(I,										
DO 200 K-1,NCA	p4			, B					•• •	
10				: A						
200 CONTINUE RETURN  102 IF(N2RA,NE,N2RB) GO TO 1000  00 400 I=1,NCA  00 400 J=1,NCB  C(I,J)=0.  C(I,J)=0.  C(I,J)=0.  C(I,J)=0.  C(I,J)=0.  C(I,J)=0.  C(I,J)=0.  C(I,J)=0.  D(I,J)=0.  C(I,J)=0.  C(	- 10						**	-	-	
102 IF(M2RA.NE.N2RB) GO TD 1000		200	CONTINUE		•					
DO 400 J=1,NCA DO 400 J=1,NCB C(I,J)=0. DO 400 K=1,NZRA C(I,J)=C(I,J)+A(K,I)+B(K,J)  400 CONTINUE RETURN 103 IF(NCA,NE,NCB) GO TO 1000 DO 600 I=1,NZRA DO 600 J=1,NZRA C(I,J)=0.  25 DO 600 K=1,NCA C(I,J)=0. C(I,J)=0. RETURN 104 IF(NZRA,NE,NCB) GO TO 1000  30 CONTINUE RETURN 104 IF(NZRA,NE,NCB) GO TO 1000 DO 800 I=1,NZRA DO 600 CONTINUE C(I,J)=0. DO 800 K=1,NZRA C(I,J)=0. C(I				•					***************************************	
15					, ,,,					
C(1,J)=0, 00 400 K=1,N2RA C(1,J)=C(1,J)+A(K,I)+E(K,J)  400 CONTINUE RETURN  103 IF(NCA.NE.NC3) GD TD 1000 DD 600 I=1,N2RA DD 600 J=1,N2RB C(1,J)=0.  25 DD 600 K=1,NCA C(1,J)=C(1,J)+A(I,K)+B(J,K) 600 CONTINUE RETURN 104 IF(N2RA.NE.NCB) GD TD 1000  30 DB 800 I=1,NCA DD 800 J=1,N2RB C(I,J)=C(I,J)+A(K,I)+B(J,K) 35 SOO CONTINUE RETURN 100 WRITE(7,2000) PORMAT(5X,*CHECK THE PROGRAM FOR MISTAKES*) RETURN 100 END	15			. M						
C(I,J)+A(K,I)+B(K,J)  400 CONTINUE RETURN 103 IF(NCA.NE.NCB) GO TO 1000 DO 600 I=1,N2RB DD 600 J=1,N2RB C(I,J)+A(I,K)+B(J,K)  C(I,J)+C(I,J)+A(I,K)+B(J,K)  600 CONTINUE RETURN 104 IF(N2RA.NE.NCB) GO TO 1000 DD 800 I=1,N2RB C(I,J)=0 DD 800 J=1,N2RB C(I,J)=0 DD 800 K=1,N2RB C(I,J)=A(K,I)+B(J,K)  35 800 CONTINUE RETURN 1000 WRITE(7,2000) PORMAT(5X,*CHECK THE PROGRAM FOR MISTAKES*) RETURN -40 END		*** * ** ** *								
20										
20 RETURN  103 IF(NCA.NE.NC3) GD TD 1000  DD 600 I=1,N2RA  DD 600 K=1,NCA  C(I,J)=0.  25 DD 600 K=1,NCA  C(I,J)=C(I,J)+A(I,K)+B(J,K)  600 CDNTINUE  RETURN  104 IF(N2RA.NE.NCB) GD TD 1000  DD 800 I=1,N2RB  DD 800 J=1,N2RB  C(I,J)=0.  DD 800 K=1,N2RA  C(I,J)=0.  DD 800 K=1,N2RA  C(I,J)=C(I,J)+A(K,I)+B(J,K)  35 800 CDNTINUE  RETURN  1000 WRITE(7,2000)				)+A(K,I)+B(K,J)						_ , , , ,
103 IF(NCA-NE-NCB) GO TO 1000	, 20	. 400							,	
DO 600 I=1,N2RA DD 600 J=1,N2RB C(IJ)*0.  C(IJ)*C(IJ)*C(IJ)+A(I,K)*B(J,K)  600 CONTINUE RETURN 104 IF(N2RA.NE.NCB) GO TO 1000  DD 800 I=1,N2RB C(IJ)*C(IJ)*A(K,I)*B(J,K)  DO 800 M=1,N2RB C(IJ)*C(IJ)*A(K,I)*B(J,K)  35 800 CONTINUE RETURN 1000 WRITE(7,2000) TOO WRITE(7,2000) TOO FORMAT(5%**CHECK THE PROGRAM FOR MISTAKES**) RETURN RE	~~	103		3) GO TO 1000						
25			DO 600 I=1,N2	2RA '				•		
DO 600 K=1,NCA C(1,J)=C(1,J)+A(1,K)*B(J,K) 600 CONTINUE RETURN 104 IF(N2RA.NE.NCB) GO TO 1000 DD 800 I=1,NCA DD 800 J=1,NZRA C(1,J)=0. DD 800 K=1,NZRA C(1,J)=C(1,J)+A(K,I)*B(J,K) 35 800 CONTINUE RETURN 1000 WRITE(7,2000) 				2RB						
C(I,J)=C(I,J)+A(I,K)+B(J,K)  600 CONTINUE  RETURN  104 IF(N2RA-NE-NCB) GO TO 1000  DO 800 I=1,NCA  DO 800 J=1,N2RB	2 K						» · · · · · · · · · · · · · · · · · · ·		, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	•
600 CONTINUE RETURN  104 IF(N2RA.NE.NCB) GO TO 1000  30 DO 800 I=1,NCA DO 800 J=1,N2RB										
104 IF(N2RA.NE.NCB) GO TO 1000  DO 800 I=1,NCA  DO 800 J=1,N2RB		600								
DD 800 I*1,NCA DD 800 J*1,N2RB						/		4 4- 4		
DO 800 J=1,N2RB	10	104	IF(N2RA.NE.NO	8) GO TO 1000						
C(I,J)=0.  DD 800 K=1,NZRA  C(I,J)=C(I,J)+A(K,I)*B(J,K)  35 800 CONTINUE  RETURN  1000 WRITE(7,2000)	30									
DO 800 K=1,N2RA  C(I,J)=C(I,J)+A(K,I)+B(J,K)  35 800 CONTINUE  RETURN  1000 WRITE(7,2000)							, . ,			
35 800 CONTINUE RETURN 1000 WRITE(7,2000)				?RA						
RETURN  1000 WRITE(7,2000)				+A{K,I}*B(J,K)		• • •	• • •			•
1000 WRITE(7,2000)		800								•
		1000		1						
RETURN 40					M FOR MISTAK	ES*) · ·				
			RETURN			·· = •				
TAIOOR CH STORAGE USED	40		END			· · · ·				•
	-41000P C	M STODACE HEE	n	7: CECONOC	the second second second					***

208	ROUTINE HATOUT	73/172 TS .	- • -	FTN	4.6+452	` ~'05/18/79	13.53.08	PAGE	1
			•	* * ** ******		1		-	***
	5	UBROUTINE HATOUT(SY	MBOL, A, MI, NI, M,	IZI					
	" CTHE VA	RIABLES IN SUBROUTI	NE ≠HATOUT≠ ARE	AS FOLLOWS					•
	C:SYMBO	L≓ IS A 6-CHARACTER	ALPHANUMERIC E	G.* A*					
-	C≠A≠ IS	THE ARRAY NAME				-	•		
5	C#H1#,A	ND PNIP ARE THE DIM	ENSIONS (VERT, HO	RIZ) OF THE					
	CPRINTO	UT			•				
	C≠M≠ IS	THE COLOMN LENGTH	DE *A* AS DINEN	STONED IN THE			•		
	CCALLIN	G PROGRAM							
	· C≠I2=0≠	CAUSES DOUBLE SPAC	ING.OTHERWISE S	INGLE SPACING					
10		IMENSION A(M,N1)		***************************************	=				
		NTEGER SYMBOL	•						
	· · · · · · · · · · · · · · · · · · ·	RITE(7,5) SYMBOL' -							
		ORMAT( +0+, A6, / )							
		0 10 I=1, H1				-· -			
15		RITE(7,20) (A(I,J)	.J=1.N1)						
• •		ORMAT(10(1X,G12.5))							
		F(IZ.EQ.O) WRITE(7,		-					
		DRMAT(+ +)						•	
		ONTINUE							
20		ETURN	•	•					
		ND							
	_						• ••	-3/2	
DOÒB CH	STORAGE HISED	.098 SECON	ne						

SUBROUTINE MATSM(A,B,C,L,MA,NA,HB,M2B,NB,MC,M2C,NC,K) DIMENSION A(MA,NA),B(MB,MB),C(MC,NC) GO TO (101,102,102,101),L  101	PAGE 1	
DIMENSION A(MA,NA), B(MB,NB), C(MC,NC) GO TO (101,102,101), L  101		-
GO TO (101,102,102,101),L  101		
GO TO (101,102,102,101),L  101	•	
5 GO TO 110 102 IF(NB*NE*M2C*OR*(M2B*NE*NC)) GO TO 1000 110 IHAX*H2B IF(L*LE**2) GO TO 200 10 IMAX*NB JHAX*HB JHAX*HB JHAX*HB JHAX*HZB		
102 IF(NB.NE.H2C.DR.(H2B.NE.NC)) GO TO 1000 110 IMAX=NB		
110 IMAX=M28		
JMAX=NB  IF(L +LE+2) GO TO 200  10	,	,
IF(L.LE.2) GO TO 200  10		
10 ' IMAX=NB		
JMAX=M2B		
DO 600 I=1,IMAX		
00 600 I=1,IMAX	<b>.</b>	
	•	
- · · - · · · · · · · · · · · · · · · ·	•	
15 A(I,J)=B(I,J)+((~1)*+K)*C(I,J)		
" IF(L.EQ.2) A(I,J)=B(J,I)+((-1)**K)*C(I,J)	•	
IF(L,EQ.3} A(I,J)=B(I,J)+((-1)**K)*C(J,I)		
	•	
600 CONTINUE		
20 - RETURN	•	
1000 WRITE(7,10000)		
- 10000 FORMAT(5X,+MATRICES NOT COFORMABLE+)		
RETURN		
OOOB CH STORAGE USED		

208KUUTINE NOEPI	13/1/2 15	FIN 4.0+432	05/18/79 13.53.08	PAGE	
7 m. 11 c 41	SUBROUTINE MULPLT(B, A, NRY, NP, NV, XNAME, YN, INTEGER LINE(61), BLANK, DOT, SYM(NP), LO, HI LOGICAL MANUAL	ME, EYHIN, EYHAX, SYH)		4	
	INTEGER XNAME(2), YNAME(2, NV)	•	.,		•
5	DIMENSION KP1(10), YMAX(10), YMIN(10), KK(10	),B(NP),A(NRY,NV)			****
The suppose of the su	DATA BLANK, DOT/1H , 1H./, HI, LD/94, 1H2/				4.27
	IF(NRY.LT.NP) STOP*NRY <np, manual*.true.<="" td="" wrong*=""><td></td><td></td><td></td><td></td></np,>				
	IF(EYMAX.EQ.EYMIN) MANUAL FALSE.				,
10	IF(EYMIN.GT.EYMAX) PAUSE*YOU HADE A MISTA	KE INPUTTING LIMITS≠ :	1	- , -	• •
	DO 10 I=1,NV YMIN(I)=1.E322' '	صدوف ويده سمس ساخب سرس		و مهاري ساسد پيشد	
	YHAX(1)=-1.E322				
- 10	CONTINUE				
19	DO 30 J=1,NV DO 20 I=1,NP		*,		. ,
			<b>A</b> .		
	IF(A(I)).CT;YMIN(J)) YHIN(J)=A(I)J) '"""	ele	N PT 4 TENT 2 D. T. MISSESSESSESSESSESSESSESSES	<del></del>	•
- 20 30	CONTINUE CONTINUE		, , , , , , , , , , , , , , , , , , , ,		•
30	TERMANDALA CO TO AT .				
	YYHIN*YHIN(1)	··· , - · · · · · · ·		• • •	
	YYMAX=YMAX(1)				
25	DD 40 I=2,NV IF(YMAX(I),GT,YMAX(I=1)) YYMAX=YMAX(I)				
	IF(YMIN(I).LT.YMIN(I-1)) YYMIN=YMIN(I)			!	
40	CONTINUE			ಳು ಪ	
41	GO TO 45			20 /	
· 30 ~- ~ · · · · · · · · · ·	AAHIW=EAHIW.			5-5-	
45	RANGE=YYMAX-YYMIN KAXIS=60.*(-YYMIN/RANGE)+1.5			$\circ =$	
	IF(YYHIN.GT.O.O) KAXIS=1 IF(YYHAX.LT.O.O) KAXIS=61	v=	or divergent a maximum dert meren	~ 덕경 .	
35	DIS=RANGE/60.			, O .	
	UT U=T				'
	XMIN=ABS(8(1)) DO 50 J=2,NP				
•	IF(ABS(B(J)).GE.XMIN) GO TO 50 XMIN-ABS(B(J))				
40	XMIN=ABS(B(J))		Va	•	
50	MIN#J CONTINUE			m	
60	3 *_ 3 3	•	• •		
/* * ****** } * * * * * * * * * * * * *	CONTINUE DO 70 K4=1,3		" N. ANDER DE ST. DESTR. DE ST.		
45	WRITE(7,80) CONTINUE	*** ** **			
80					
	WRITE(7,90)	- Marian Anna Anna Anna Anna Anna Anna Anna A	A 1849 1 4 B b or specimen with me had men		
50 90	FORMAT (2X, 7HLEGEND:)				
50	DD 100 I=1,NV WRITE(7,110) SYM(I),YNAME(1,I),YNAME(2,I	AYMIN(T) AYMAX(T)	•		
100	CONTINUE ·				
110	FORMAT(8X,A1,2X,A8,2X,A8,5X,4HHIN=,G13.6	·3X · 4HMAX · ·			
55	*613.6)	•	-		
,	WRITE(7,80)				
	WRITE(7,80)				

TUDROUT	INE HUL		' 'FTN	4.6+452	05/18/79	13.53.08	PAGE	2
	115	WRITE(7,115) XNAME(1),YYMIN,YYH FORMAT(2X,AB,5X,14HOROINATE AXI *7H MAX=,G13.6)	S:,6H "MIN=,G13.6,					
	120	WRITE(7,120) XNAME(2),DIS FORMAT(3X,A8,30X,10HINCREMENT=,; DO 130 J=1,61	2X,613.6,/)		, , , , , , , , , , , , , , , , , , , ,	· -		
65	130	LINE(J)=BLANK CONTINUE		•	, -	4 A		
•	-	DO 170 J2=1,NP IF(J2.EQ.HIN) GO TO 180 LINE(KAXIS)=DOT				•		
70	1	DD 140 I*1,NV X=60.0*((A(J2,I)=YYMIN)/RANGE) KK(I)=X+1.5	20 yr 13 - mig dir hand handy synt. (14 marca may appear in M.Ca. ) - appear					
		IF(KK(I).GT.61) LINE(61)=HI IF(KK(I).LT.1) LINE(1)=LO			•			
75	135	IF(KK(I).LT.1.OR.KK(I).GT.61) G( LINE(KK(I))=SYH(I) IF(KK(I).GT.61) KK(I)=61	J 10 135				•• •	
	140_	IF(KK(I).LT.1) KK(I)=1 CONTINUE WRITE(7,150) B(J2),LINE				··	•	
80	150	FORMAT(1X,G13.6,6X,61A1) DO 160 I=1,NV	,					
•	160 170	CONTINUE CONTINUE CONTINUE	-	•		-		
. 85	180	GO TO 211	16 men men 17 men men 18 men 1			er summan and an annual sand		
90	- 190 	CONTINUE						
		X=60.*((A(MIN,I)-YYMIN)/RANGE) KPI(I)=X+1.5 IF(KPI(I).LT.1) LINE(I)=LD	** 1	*** ** ** **				
95		"IF(KP1(I).GT.61) LINE(61)=HI "IF(KP1(I).LT.1.OR.KP1(I).GT.61)"	GD TB 200 .	•	<u>.</u>			
, , , , , , , , , , , , , , , , , ,	200	WRITE(7,150) B(J2),LINE						
100	210 -	LINE(J) * BLANK CONTINUE						
	211 -	GO TO 170 DO 220 K5=1,3° """		•		•		
.105	220 ·	CONTINUE	s and the of the ten over that 3	e	,			
	230	CONTINUE RETURN				<u>.</u> .		
110	. н	END	actual peri agree grow has been as because a					

SUBROUTINE	PLOTA	73/172	ΤŜ	•	•		* FTN	4.6+452	05/18/79	13.53.08	PAGE	1
					***		, .				,	
		SUBROUTINE PL DIMENSION B() INTEGER HI, LOGICAL MANUA	NP),A(NP) LO,LINE,E	LINE	61)	, EMIN, E	MAX, ISC	}	· ··,			•
5		INTEGER XNAME DATA BLANK, DO SYME - FALSE.	E(2),YNAN DT,STAR/1	1E(2) LH ,1H	,1H*/,HI	/94/,LO	/1H≥/	» ·		,		
	,- ·	MANUAL . TRUE			•							•
10		IF(EMAX.EQ.E) IF(EMIN.GT.E) IISC=ISC	1AX) STOR	y≱YDŲ ≀	IN A BOAP	STAKE II	NPUTTING	G EMIN % E	MAX#TTHTT	P 84 A PIN VIR 188	••	
		IF(MANUAL) I										
15		IF(MANUAL) GO YMIN=1.E38 YMAX=-1.E38	i în II									•
	'	DD 10 I-1.NP									,	
		IF(A(I).GT.Y	MIN) (MA)	N=A(I)								
20	10	CONTINUE GO TO 19	,				,.			* *		
20	11	YMAX=EMAX										
<b>k</b> #	19	YMIN=EMIN YMIN=ARS(R()	11	•	• •		• •		•			
	•′,	XMIN=ABS(B(1 MIN=1			1· · ·	<del>.</del>	·· ··		., .,	Specialization of the state of	• •	
25	•	DO 20 J=2,NP IF(ABS(B(J)) XMIN*ABS(B(J	GE . XMIN	- GO 1	TO 20 ~	, <u>.</u> ., .		****		,,, d	ŧ	
		MIN=J ~	'' <i>.</i>	-			٠	·· -				
. 30	20 .	CONTINUE IF(IISC.EQ.O RANGE=YMAX-Y	M T SI					/	t as made			
		KAXIS=60.+(-	YHINZRANO	GE)+1.	5			•		3 (A 800) E		
		IF (YMIN.GT.O	.O) KAXIS	5=1 5=61 -	** * * * * * * * * * * * * * * * * * * *		• • •	•				•
35		DIS=RANGE/60 GB TO 30	• _					••				
	21	IF (YMIN.GT.O IF (YMAX.LT.O	.) GD TO .) GD TO	22 23	, 1				• •			
40		KAXIS=31 Syme=.True.				. — н	, ,	4	•			
	41	ABY=ABS(YMIN RANGE=AMAX1(	}								**** *	
		DIS=RANGE/30 GO TO 30	THAXJABY •	,	•							
45	22									. `.		
								•	* *		•	•
				P.484 N P.		., , .		* ** *			4 · .	
50	23	KAXIS=61 Range=-Ymin			. ,	,				*		
	24	DIS=RANGE/60 CONTINUE	•					•		_	•	
•	30	DO 40 K4=1,3	• •				•			-		
55	40	WRITE(7,50)							6 36 48 49	MRHL 7 MF 4 M5 4	•	
99	50	CONTINUE FORMAT(1HO) WRITE(7,60)			. ,., /11.VHTÑ.				4 *			
		4VT1E111001	MIRABELLI.	JUVUL	FTILLUTUI	IЛАĂ						

- SUBROU	TINE PLO	TR " 73/172 TS	7	FTN 4.6+452	05/18/79 ~ 13.53.08	PAGE	2
	60	FORMAT (2X,A8,7X,A8,3X,20HORDINATE		=	444 4 144		
		*G13.6)		• • • • • • • • • • • • • • • • • • • •	E MH 7 7 N N N T N E M 7	•	
60		WRITE(7,70) XNAME(2), YNAME(2), DIS					
*	70	FORMAT(2X, A8, 7X, A8, 25X, 10HINCREME	NT=,G13.6,/	<b>}</b>	•	•	,
		DO 80 J=1,61 LINE(J)=BLANK					
		LINE(J) = BLANK					
	80	CONTINUE			, , , , , , , , , , , , , , , , , , ,	-	
65		OO 100 J2=1,NP					
		IF(J2.EQ.HIN) GD TO 110 X=60.0*((A(J2)-YHIN)/RANGE)		- ,			
		IF(IISC.EQ.O.AND.YHIN.GT.O.) X=50	*/ 4/ 121/DA	NCEL			
		" IF(SYME) X=30.+(A(J2)/RANGE)+30.	J. W. O. S. S. KW	100)			
70		K*X+1.5					
		LINE (KAXIS) = DOT					
		IF(K.GT.61) LINE(61) =HI 					-
		IF(K.GT.61) GO TO 89					
75		* IF (K.LT.1) LINE(1) = LO					* "
		IF(K.LT.1) KHAX=KAXIS			•		
		IF(K.LT.1) GO TO 89		•			
		LINE(K)=STAR					
		. KUUY-KUXIZ	•			•	
80	89	IF(K.GT.KMAX) KMAX≃K 'WRITE(7,90) B(J2),A(J2),(LINE(N4)	.NAW1.VMAY1				
	90	FORMAT(1X,G13.6,2X,G13.6,2X,61A1)	PRTTAPRIMAL				
	., ,,	IF(K.GT.61) LINE(61) *BLANK					
85			<del> </del>				
		IF(K.LT.1) GO TO 100					
.,,		TINE (K) = DEWNY					t
	100	CONTINUE					
		GO TO 145		·			
90	110	CONTINUE					
-, , ,		DB 120 J=1,61	• •	•			
	120	LINE(J)=DOT CONTINUE		10 17 974 974	* * ** ** ** ** **		
	120	X=60.*((A(MIN)-YMIN)/RANGE)					
- 95 -		IF(IISC.EQ.O.AND.YMIN.GT.O.) X=60	* ( A ( .12 ) / R A	NGF1			
7.4		TE(SYME) X=30.*(A(J2)/RANGE)+30.		11027			
•		IF(SYME) X=30.*(A(J2)/RANGE)+30. KP1=X+1.5					
		IF(KP1.GT.61) LINE(61) =HI IF(KP1.LT.1) LINE(1) =LO				-	
100		IF(KP1.LT.1.OR.KP1.GT.61) GO TO 1	.29				
,			(	~			
	129	WRITE(7,130) B(J2),A(J2),LINE					
	- 130	FORMAT (1X, G13.6, 2X, G13.6, 2X, 61A1)		-	•		
		DO 140 J=1,61					
105		FING (3) * BLANK					
	140	- GO TO 100					
<b>-</b>	145	00 10 100 00 150 K5m1-3	"				
	_ 143	DO 150 K5-1,3 WRITE(7,50)					
110	150	CONTINUE	_				
* ******		- EHAX=YMAX					
		EMIN=YMIN					
• 3	160-				•		
		RETURN					

A-108	

s	UBROUTINE PLOT	TR ' ' '''	73/172	TS	•	•	-		FTN	4.6+4	52 ;	05/18/79	13.53.08	PAGE	3
								~ ~	··· · · ·	-, -				- · · · · · · · · · · · · · · · · · · ·	
115		END		٠.											
	CH STORAGE USE		. 82	L7 SECOI	1DS :							* *			

	FUNCTI	ON PVALUE ~ ~	73/172	τs	•	-	,	FTN 4.6+	452	05/18/7	9 13.53.08	PAGE	1
·										** ** **			, ,
	•	FUNC	TION PVAL	UE (X.P.D	EL)								
		C .	, , , ,		•							÷ 1	•
		C THIS	ASSUMES	X RANGES	ON THE	REAL LIN	E. MODUL	D 2P AND					
		C REDUCES							MALL ''				-
	5	C INTERVAL	. ABOUT TH	E DRIGIN	, (-DEL	DEL).					_		
		C -,			,				,				
		B = X /	•										
			(AMOD(ABS			•	BJ 1	•			t	• -	
	_		DEL, .NE.		GN (AHAX)	1(AHIH1(A	BS(C),P-	DEL),DEL).	•C)				
10	0 '		B.LT. 0.)	C=-C ,	• • -	,			* 10				
			.UE #C										•
	( (	THE RETU	RN										
		END											
/100							-			-	41.0 4.04	,	
41000	OB CH STOR	WRE AZED	.09	2 SECOND	5								

SUBROUTINE REALID(SYMBOL, VALUE, IZ)  INTEGER ISH, ISLASH, SYMBOL  OATA ISLASH/1H//  IF(IZ) 1,2,3	
INTEGER ISW, ISLASH, SYMBOL  OATA ISLASH/1H//  IF(IZ) 1,2,3	
IF(1Z) 1,2,3	
5 1 READ(10,10) VALUE	
10 FORHAT(G13.6)	
WRITE(7,20) VALUE	•
RETURN	
TIONTE 2 WRITE(7,30) SYHBOL, VALUE TO THE TOTAL TO THE TOTAL TO THE TOTAL TOTA	
30	
READ (10,40) ISW, VAL2	
40 FORHAT (A1, G13.6)	
IF (ISH .EQ. ISLASH) GO TO 60	
15 WRITE(7,50)	
50 FORMAT(1H )	•
RETURN	
Time transfer to VALUE=VAL2	1 14
WRITE(7,70) ISLASH, VALUE	
· 20 · · 70 FORMAT(1H+,22X,A1,G13.6/) · · · · · · · · · · · · · · · · · · ·	
RETURN	
3 WRITE(7,80) SYMBOL,VALUE	
80 FORMAT(1H ,60,3H = ,G13.6/)	
RETURN TENED TO THE RETURN THE TANK THE	•
25 END -	
the control of the co	
410008 CK STORAGE USED .098 SECONDS	
and the control of th	

SUBROUTINE RETU	RN 73/172 - TS		 FTN 4.6+452"	05/18/79 13.53.08	PAGE · 1
			 	1 there # 25 % b # 25 m #4 from #4 from 4 mm #	
	SUBROUTINE RETURN(LF)	()			
	DIMENSION FIT(1)		 •		•
	IX×INDXFIT(LFN, FIT)	1			
	CALL STOREF(FIT(IX),	LCF,1LU) ~"~	 •		•
	CALL CLOSEM(FIT(IX))				
	RETURN		 	· · · · · · · · · · · · · · · · · ·	
	END				
		** * * * * * * * * * * * * * * * * * * *	 		
41000B CH STORAGE USE	O	)S			

	-		FUN	CTION	SATU	73/172	TŞ	٠		• •		•	FTN	4.6+4	452	05/	ĺ8/79	13.53.	08	PAGE	1
																			····		
					-	FUNCTION SAT	E.XL) G	0 TO 2							•				•	-	
	• •			•		SATU-SIGN(XL. RETURN	, X )	•								•			-	•	
-		٠.			2	SATU=X RETURN			.,		٠					-	••				
		OB	CH S	TORAG	E USEI	END	46 SECO										•	•	•		
			•				70 JEGU			,							~				

	PROGRAM	PCRM	73/172	TS		FTN 4.6	5+452	05/17/79	16.20.35	PAGE	1
								7 E 102 ( 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2			
	. ,	*	PROGRAM PCRMI Tape201	P1 (INPUT, C	OUTPUT, TAPELO = INP	UT, TAPE15, TAPE7	7=DUTPUT				
			INTEGER DATIM	4(4)			_				
					102), TODAY(3),P						
5_					15(3), ESTDEV(3), T						
					CSNRTO(102), THES		3), CSNRFR(10	2) '			
• •					)RT(100),THESER(1 \ME2(10),NAME(10)		00/21	,,-			
			DIMENSION NAM	12EP(3)*N0	MSNR(2),NAMTIM(4	)	(KLS)				
10			DIMENSION YOR		,	•					
			EQUIVALENCE	(RNAMEZ, NA	ME2(10)), (RNAME,	NAME(10))					
			DATA YMMAX/1	0/#H/0.07	//.SIZE/0.5/.S/.1	2/					
	MA - 11 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -	٠	DATA NAMEI/10	DHSIM. JOB	1:,,3*1H ,10H FIL	E NO: ,3*1H ,10	OH , DATE: ,	·			
15			TH /								
			10H DATE:		טאין, מטבנ חביים נייי	GRAM + JIUMPUKM	'L		· · · · · · · · · · · · · · · · · · ·		
			DATA NAME/10								
			DATA DATIN/10		TA,3+0/				1		
			DATA NAMSNR/			1	* 1.				
20			DATA NAMSEP/I	LOH SEPA	RAT, 10HION ANGLE	,10H(DEG.)	. <del>/                                   </del>	_		•	
**** * * * * *			DAIA NAMIINYI 117	TOHEIME 21	NCE, 10H START OF	JIOHFIRST SCAN	I, 10H, (SECON	)5			
			DATA ALXTIM/S	5.0/		•					
*****		•	DATA ALYERR/		5/			/ /********************************	V		
25		<i>.</i>	DATA ALYSNR/	2.0,1.5,1.	T ,						
			DATA YPK/1.37			-					
					0,6.0,3.25,0.0,6	.5,4.5,2.5/ 🚬		,			
		c	DATA YORSNR/1	r.o/) IRCAN	IK/2H /						
~~~ 30 °		Č -	** / 44 / /********** *		v# . • ; ~ •	*1 **** / ** /	n4 A		····	······································	
		Ċ	~			_					
			CALL CALCOMP								
-			CALL PACTOR (
35			CALL PLOT(2.0 MAME2(2)=JOBN							00.	
			RNAMEZ-DATE (A		ar i si fee	• • • • • •	~			77 37	
			READ(10,10) N							P AS	
			FORMAT(12)	•		,		> 2		0 Z	
	-		WRITE(7,20) N							ŏ\$	
40			17H PLOTS TO		A10,15X,7HDATE:	\$A10//1H \$135				3 P	
** **			******		,	** * **	t t et. venibre	,.,		O 38	
			DD 320 NP=1,N			_			•	23	
•			READ(10,30) N	RFILES	,,, , , , , , , , , , , , , , , , , ,		7 77			- CD	
45		30	FORKAT(I1)							29	
	1	-	*********			•				750	
******			DO 180 N=1,NF READ(10,40)				معرف من الم		······································	- (
			FORMAT (53X) A1								
50					(DATIN(I),I=1,2),N,NFILES					
	. 	50	FORMAT(6H1PLC	T ,12,4H	DF , 12/12H INPUT		(,13,	*** ** **			
		*	4H OF , [3,2H)	1/)	*****						
• • • •			TK=IATTACH(6L	.farel5,DA	TIN)						
55			IF(IR.EQ.O) G WRITE(7,60)	,, ,, ,,							-
	•			LE ATTACH	NOT SATISFACTOR	Y# '			* * * * ***		
			FORMAT(20H FI								

•	PROGRAI	1 PCRKP1	73/172	2.7		FTN 4.6	+452	05/17/79	16.20.35	PAGE	2	
						•	. , ,		****		····································	
	. ,	C C READ F	ILE INTO NTH	ELEMENTS OF A	ARRAYS, WHERE	NECESSARY	»·•.	•				
60				N),DELT,MTIMES		DAY(N), JBNAM(н)					•
				ITS(I,N),I=1,6] I,DSNRDB,RHD,BE		BRCVR	,,,,		va	, ·		
65		C*******	*********** 80 K=1,KH	30		•		•				** ** ***
	. ,		AD(15) CSNRT NTINUE	TO(K),CSNRFR(K)),THESER(K,N)	,ABBORT(K),TH	ESEP(K).	٠				
	-		AD(15) EMEAN LL RETURN(61	((N),ERMS(N),E: .TAPE15)	STDEV(N),TCOU	NT(N),YMIN(N)	(N)XAHYe				,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
70		C C WRITE	DATA ON LINE	PRINTER AS IN	CONTROL	•					- · ·	٠
·		C WR	ITE(7,90)	DOUT (N), DELT,	MTIMES,LGMAX,	KM, TODAY(N), J	BNAM(N)	·	., ,		*****	
75),8X,G13.6,5X,; (IDENTS(I,N),I		A10,8X,A10/)				·		
-			RMAT(1H ,6() (ITE(7,110)	LX,AB,9X)/) NRUN,DSNROB,RI	HO, BETA, FSC, B	MLS, BRCVR				. ,, .	•• •	
		C*****	*********	,12,6X,6(5X,G1: L30	3.6)/)			, .		** *** ** ** **		•••
80	• "	WR		SNRTO(K),CSNR			THESEP(K)	•к		فع و مکانس سنب مانین بر برجوج		
		130 CC	NTINUE	313.6,5X),6X,A	1,11X,G13.6,5	X, 17)	•			matala Mining		
8 5		0.0	************ 150 K*1,5	150	• •		,* \				• •	• •
,	• •	140 FC	RITE(7,140) DRMAT(1H ,5(6 DNTINUE _,	6X,1H.,11X)) '	: had day days of the de	•	/ ^					
90			13=KM-3 ************	160		•			* ***** ** **	হ ত্র	_	••
	•	, WF	160 K=KH3, RITE(7,120) (INTINUE	KM CSNRTO(K),CSNR	FR (K), THESER (K,N),ABBORT(K	(),THESEP(K).	• K,				
95		WF		EMEAN(N), ERMS	(N), ESTDEV(N)	*TCDUNT(N) *Y	IN(N),YMAX(м) _				•
			NTINUE		• • •				s 27 116 -	, , , , , , , , , , , , , , , , , , ,		•
			EFT EDGE OF		** '	•					, , ,	
. 100		C CA	ALL PLOT(-2.	0,7.0,2)					•	•		
•		C WRITE	INFORMATION	ON THE TOP OF	THE PAGE				- ••		•	
105			1=8.8-\$ 1=-0.5	•	,			• •				· -
		Ya	2H = 8 - 8 - (NFIL		.0,90}	• .						
•		00	190 I=1,10		• •				. +	•		
110		190 C	AME(I)=IBLAN ONTINUE					•	,		· ·· -	
		D	************ 3 200 N=1,NF MA(2)=JBNAM	ILES						•		

	PROGRAM PCRMP	1 73/172 TS	FTN 4.64	+452 05/	17/79 16.20.35	PAGE	3
		• • • •			,		
115		DECODE(10,195,DUUT(N)) NAME(6),		AT 21	45 7 7 2 247-247 27-4 27-4 27-4 27-4 27-4		
		FORMAT(A10)					
		RNAME = TODAY (N)	,	-	. ,		
		Y1H×8.8-N+S Call Symbol(XH,Y1H,H,name,0.0,10	101				
120		CONTINUE	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,				
		CALL SYMBOL (XH, Y2H, H, NAME2, 0.0, 1	.00}				
	C						
	C ORIG	INATE TIME DELAY	W 4 BL 498 1 B	*) * * .			
125	C	KM1=KM+I					
		KM2=KM+2	the state of the second of the state of	_ , ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		······································	
		***********			·		
		DG 210 K=1,KH		•	*** ** ********************************		
		K1=K-1	, , , , , , , , , , , , , , , , ,	.,	.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		
130	•	TIM(K)=DELT*K1					
	,	MAX, MIN, AND INCREMENT FOR CSNTE	10				
	Č	THAT THE PARTY THE COURT OF COURT			ŀ		
		CONTINUE	,				
135		CSNRTD(KM1)=0.0	•			·	
		SNRING=IFIX(CSNRTO(1)+.5)			•		
		CSNRTD(KM2)=SNRINC YMM=YMMAX			***************************************		
		YMIX=-1.E+320					
140		ALX*ALXTIM/SIZE					
		CALL SCALE(ŢIM+ALX+KM+1)					

		DO 220 N=1,NFILES YPEAK(N)=AMAX1(-YMIN(N),YMAX(N))	AL 3 75 W 1 4 8 5 1 M 1 M 1 M 1 M 1 M 1 M 1 M 1 M 1 M 1		***************************************		
145		YMIX=AMAX1(YPEAK(N),YMIX)					
		CONTINUE	• •	•		·	
		YMM*AHIN1(YMM,YHIX)					
	C+***	***********			•	•	
150		DB 260 N*1,NFILES			w		
190	6****	DO 230 K=1,KM	•				
		YY(K)=THESER(K,N)					
		ZS#SIGN(YMH,YY(K))			-		
		IF(ABS(YY(K)).GE.YMM) YY(K)=ZS+Y	MM				
155		CONTINUE ENCODE(23,240,PKVAL) YPEAK(N)	A temperature - te n	PA THP 67	~ · · · · · · · · · · · · · · · · · · ·		
		FORMAT(13HPEAK VALUE = ,F5.3,5H	DEG.)				
· · · ·		YY(KMI)=-YMM	2201	***			
		YY(KMZ)=2.+SIZE+YMM/ALYERR(NFILE	S)				
160		CALL FACTOR(1.)					
		CALL PLOT(0.0, YORERR(N, NFILES),-	3). , " , ,	- 4 17 10 7 45 750			
		XB=-3.0*S YB=YPK(NFILES)					
4 1		CALL SYMBOL(XB,YB,H,PKVAL,90.0,2	3) ~		* * *		4.
165		CALL FACTOR(SIZE)		_			
-		ALY=ALYERR(NFILES)/SIZE		·			•
		ENCODE(17,250,NAMERR) IDENTS(3,N	0	, m.			
		FORMAT(A8,9H RECEIVER) Call Axis(O.O,O.O,NAMERR,17,ALY,	90.0.77(KM1).77(KM2))				
170		CALL LINE(TIM, YY, KM, 1, 0, 0)	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,				

	PROGRAM PCRMP1	73/172 TS	FTN 4.6+452	05/17/79	16.20.35	PAGE	4
	260 COI	LL PLOT(0.0,-YORERR(N,NFILES),-3 NTINUE					
175		LL PLOT(0.0,YORSNR,-3) LL FACTOR(SIZE)	•				
	- ALI	LY=ALYSNR(NFILES)/SIZE				·	
	, CAI	LL AXIS(0.0, 0.0,NAMTIH,-40,ALX, LL AXIS(0.0,0.0,NAMSNR,14,ALLY,S	90.0,CSNRTO(KM1),CSNRTO(KM2))				
180		SiTHESEP(2)-THESEP(1) MIN=THESEP(1)					
	7.5	INC*(DTS/DELT)*TIM(KH2) S=5/SIZE	•				
	CA	LL AXIS(O.O, EPS, NAMSEP, -30, ALX, (O.O.TSHIN, TSINC)				
185		LL LINE(TIM,CSNRTO,KM,1,0,0) _ LL FACTOR(1.0)	••	•		 -	
	CA	LL PLOT(0.0,-YORSNR,-3)					
		± — • 4 4. = — \$					
190	270 FD:	CODE(93,270,NAME)DSNRDB,RHO,BET/ RMAT(4HS/N=,F5.1,5H DB, ,5H RHO=	A,FSC,KM,BMLS,IDENTS(2,1)	6.			
	*>41	HFSC=,F6.1,5H HZ, ,3HKM=,14,8H S	SCANS, ,5HBMLS=,F5.2,2H, ,A8)				
•	YH	LL SYMBOL(XH,YH,H,NAME,0.0,93) =YH-S		,	** ** ****		· -
195		***********310 310 N=1,NFILES	M-1 ,	-, ,			
±/3	YH	■ YH-S		4		,	
		CODE(10,280,DOUT(N)) AA,BB,CC RMAT(A2,A1,A7)					
. 200		CODE(1,285,88) IRCVR RMAT(II)		•			
. 200	IF	(IRCVR.EQ.1) ENCODE(78,290,NAME)	(IDENTS(I,N), I=3,5), TCOUNT(N	}•		~	
		MS(N) RMAT(A7,3H: ,A7,2H, ,A8,2H, ,F6	6.2.20H% OF SCANS ABORTED	•		n () to 1-0 -	•
205	, , ♦ 5HI	ERMS=,G13.6,5H DEG.) (IRCVR.NE.1) ENCODE(78,300,NAME)					
~	+ÈR!	MS(N) .				-	
		RMAT(A7,3H: ,A7,2H, ,A8,2H, ,A6 ERMS=,G13.6,5H DEG.)	5,8H, BRCVR=,F4.2,8H DEG., ;	•	•	•	
210	CA	LL SYMBOL(XH,YH,H,NAME,0.0,78)	•			-	
510	A O	LL PLOT(8.5,0.0,-3)			•	• •	
	. 320 . CDi	NTINUE LL PLOT(-2:0,0.0,3)					•
215	CA	LL PLOT(-2.0,7.0,2)	•				
213	STI	LL ENDPLT Op ,					
• -							

	W 73/172 15	FTN 4.6	1772	05/18/79 13.53.23	PAGE
		, ,,,,,,,,	**		د در در مساس
	PROGRAM RLOGSW (OUTPUT, TAPE10, TAPE7=0	OUTPUT)			
C TI	IIS READS (SWA), (SWB), % (RAB)				
	REAL NC(1000), NS(1000)				
	INTEGER FNA(4)	•			•
5 '	COMMON/DATAI/QA,B,U,WAA,WBA,WAZA,WBZ/				
	COMMON/DATA2/LHAX1,COSB,JNHAX,NC,NS,/			,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	******
	DIMENSION QAI(25), BJ(12), BULK(12, 25, 3	i), DATUM (5), COSB (101)		
	EQUIVALENCE (WAA,DATUM(1))		•		
	DATA PI/3.1415927/, LMAX/100/, JNMAX/10	00/,JBHAX/12/			
10	DATA FNA/10HMLSLOGSWCD,1LC,2*0/			•	
C					,
C- FOLI	OWING READS DATA FROM FILE			. ,	•• • • • •
	IX=IATTACH(6LTAPE10,FNA)				
4> 4	READ (10) LMAX1, JNMAX	•	•	.,	
15	READ (10) IQMAX, (QAI(I), I=1, IQMAX)				Š
	READ (10) JBHAX; (BJ(J); J=1; JBHAX)		•	• - / •	
	READ (10) (((BULK(J,I,K),J=1,JBMAX),1	[=1,IQMAX),K=1,3)		•	
	الله لا يون الله الله الاستخداد الله الله الله الله الله الله الله ا				,
	DO 80 K#1,3		•	+	
20	IF(K.Eq.1) WRITE(7,870)	• •			
	IF(K.EQ.2) WRITE(7,871)				,
	IF(K.EQ.3) WRITE(7,872) " " "		, ,	** * *	
870	FORMAT (1H1,///,5HOSWA:)		•		
871 ~	FORMAT' (1H1,///, 5HOSWB:)			the first sense are sense that he first he is	++ 1 +
25 872	FORMAT (1H1,///,5HORAB:)				
₩	WRITE (7,880) (BJ(J),J=1,JBMAX)	* *	•		
880	FORMAT (4H08 = 8X 12(2X 16.3 2X))				
	WRITE (7,885)	· · · · · · · · · · · · · · · · · · ·			•
885	FORMAT (4H QAI)				
30	DO 70 I=1, IQHAX " ""			e days and home ensures	•
	WRITE (7,890) QAI(I), (BULK(J,I,K),J+1	JBMAX)			
- 890	FORMAT (1H , G11.4, 12(1X, G9.2))	. ,	•		r
70	CONTINUE				•
80 -/	CONTINUE			••	
35	STOP				
	END 1		Ar		• •
	w. 1 m	•			•
		•			

	PROGRAM WLOGSW(INPUT, DUTPUT, PUNCH, TAPE12, TAPE5=INPUT, TAPE7=DUTPUT,
	1 TAPEG * PUNCH)
	C THIS COMPUTES (WA>, <wb>, <swb>, % <rab></rab></swb></wb>
	** REAL NC(1000), NS(1000)
5	COMHON/DATA1/QA,B,U,WAA,WBA,WAZA,WBZA,WABA,WA,WB
	COMMON/DATA2/LHAXI, COSB, JNHAX, NC, NS, ALNLHX, RIJHAX
	DIHENSION GAI(25), BJ(12), DATUH(5)
	DIHENSION DATA3(12,25,3),BULK(12,25,3),COSB(101),DATA4(937) EQUIVALENCE (WAA,DATUH(1)),(QAI(1),DATA4(1)),(BJ(1),DATA4(26))
10	- EQUIVALENCE (DATA4(38), DATA3(1,1,1))
	c
	DATA PI/3.1415927/, LMAX/100/
	DATA JNHAX/1000/, IQHAX/25/, JBHAX/12/
15	DATA QAI/-1,-1778,-3162,-5623,1-,1-778,-3-162,5-623,10-,
,	*17.78,31.62,56.23,100.,177.8,316.2,562.3,1000.,1778.,3162., *5623.,1.E4,1.E5,1.E6,1.E7,1.E8/
	DATA BJ/.01,.02,.04,.06,.1,.2,.3,.5,.7,.9,.95,.99/
	C
	SQ22=SQRT(.5)
- 20	" READ(5,8)LMAX, JNMAX """ " " " " " " " " " " " " " " " " "
	8 FORMAT(215)
	TRINITE(7,9) LHAX, JNMAX
	9 FORMAT(7H LHAX* >15/8H JNHAX* >15/) TO BETAZ*PI/LHAX****
25	LMAXI = MAX+1
	DG 10 L=1, LMAX1
	COSB(L)=COS((L-1)*BETA2)
	10 ··· CONTINUE ··· ·· ·· ·· ·· ·· ·· ·· ·· ·· ·· ·· ·
30	DD 15 J=1,JNMAX
3 0 ,	NS(J)=SQ22*GAUSS(O.) NS(J)=SQ22*GAUSS(O.)
	15 CONTINUE
	ALHAXI=LHAXI
	- ALNLHX-ALOG(ALHAX1)
35.	RIJMAX=JNHAX+ALHAXI
•	WRITE (7,800) LHAXI
	800 FORMAT (1H ,14,25H VALUES OF BETA (O TO PI)) ''
	WRITE (7,810) LHAX1
40	810 FORMAT (1H)14,27H VALUES OF BETA-U (O TO PI))
	WRITE (7,820) JNMAX
	820 FORMAT (1H-, 15, 34H VALUES OF NOISE SAMPLES (NCJ, NSJ)) - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -
	30 CONTINUE WRITE (7,830) QAI(1), QAI(2), QAI(1QHAX), IQMAX
45	830 FORMAT (4H QA=,G13.6,2H, ,G13.6,6H,, ,G13.6,2H (,I2)
	* 8H) VALUES)
	WRITE (7,840) BJ(1),BJ(2),BJ(JBHAX),JBHAX
	7840 TM FORMAT (3H B=, F7:4, 2H, ,F7:4,6H, .:.) F7:4;2H"(,12, TT (12) TT (TT (TT (TT (TT (TT (TT (TT (TT (TT
	* BH) VALUES)
. 50	QA=QAI(I) .
	- DO 50 J=1, JBHAX
	B=BJ(J)
	CALL WAVGS
55	DD 45 K=1,3
· · ·	45 CONTINUE
	45 · CONTINUE

·· · · PRO	GRAH WLI	DGSW ' ' 73/172 TS .	FTN 4.6+452	05/18/79 13.53.19 PAGE 2
	50	CONTINUE	.,	y name and no non-more reference on more to be in
	77.60	CONTINUE		•
60	Ç	CHANGES TO LOG		, , , ,
		DD 100K=1,2		
		DO 100 I=1, IQMAX		
		DD 100 J=1, JBMAX'		**************************************
		DATA3(J,I,K)=ALOG(SQRT(BULK(J,I,K)))	•	
65	100	' CONTINUE ' " '	,	
		DO 200 I=1, IQHAX		
		"" DO 200 J=1, JBMAX , '		13 A 3 4 Mr 9 Mr 20 MM AM
	200	DATA3(J,I,3) *BULK(J,I,3)/SQRT(BULK(J,	T. 11*BULK(J. I.2))	
		PUNCHES CARDS	2,2,1,2,2,1,2,2,2,2,2,2,2,2,2,2,2,2,2,2	
70	• .	XAMBL+XAMPI+XAMBL*XAMPI*E=LLII		
		WRITE(6,900) LMAXI, JNMAX, IQHAX, JBMAX,	4 * **	
	900	FORMAT(4(15,5X),26X,*MLSLDGSWCDC*,13)		
	YUU			
	0.01	WRITE(6,901) ((DATA4(I),I+1),I=1,IIJJ	•	
	901	FORMAT (G23.16,43X,*MLSLOGSWCOC*,13)		erata o movembre a months a months of the state of
(5	ų i	RITES ON DATA FILE LOGSW2.DAT ""		i
		WRITE(12) LMAX1, JNMAX	_	
		WRITE (12) IQMAX, (QAI(I), I=1, IQMAX)	·	
		WRITE (12) JBMAX, (BJ(J), J=1, JBMAX)		·
** *		WRITE (12) (((DATA3(J,I,K),J=1,JBMAX)	,I=1,IQMAX),K=1,3) ~	** *** ** * * * *
80	C	RITES ON DECURITER		
• /	- c			
		00 80 K=1,3		
	•	IF(K.EQ.1) WRITE(7,870)	-	- 1 - 1 4 44
		IF(K.EQ.2) WRITE(7,871)		
. 85		- IF(K.EQ.3) WRITE(7,872)		** 1 **** * * * *
	870	FORMAT(/,1HO,4HSWA:)		
	- 871	FORMAT(/,1HO,4HSWB:)		
	872	FORMAT(/,1HO,4HRAB:)		
				21 am mm .
	200	WRITE (7,880) (BJ(J),J=1,JBMAX)		·
90	880	FORMAT (4H08 =,8X,12(2X,F6.3,2X))		
		WRITE (7,885)		
	885	FORMAT (4H QA:)		
,	` •	" DD 70 I=1, IQMAX ' ' ' '		
	•	WRITE (7,890) QAI(I), (DATA3(J,I,K),J*	(1, JBMAX)	•
95 .	890	FORMAT (1H ,G11.4,12(1X,G9.2))		•
	70	CONTINUE		
	80	CONTINUE		
		STOP		
·		END 'Car allest comments of the contract of th		
		B114		•
10008 CM ST	00105 111	SED		-

' SUBROU	ITINE WAWB	73/172 TS	FTN 4.6+452	05/18/79	13.53.19	PAGE	1
			www.a. At the glad of the to place and and per of gr		***********		*****
	CTUTC	SUBROUTINE WAWB					
	CIUTZ	COMPUTES A SAMPLE EACH OF THE PROCE REAL NC(1000), NS(1000)	:22F2 MY % MR				
		COMMON/DATAI/QA,B,U,WAA,WBA,WAZA,WE	12 A . L'AÑ A . VA . V.O				
5		COMMON/DATAZ/LHAX1, COSB, JNHAX, NC, NS					
**** *** * * * * * * * * * * * * * * * *		DIMENSION HA(101), H8(101), COSB(101)					
	C		7412-171111111				
•	* ** ****	GHAX=-1.E+322					
		HMAX=1.					
10	,	HAMAX*I.	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		,		
		HBMAX=1.					
		DO 20 L+1, LHAX1 COSBL+COSB(L)					
		BCBL1=AHAX1(1.+B+COSBL,O.) "	`				
15		ABC=QA+BCBL1					
	-	UABC=U*ABC					
		RAD#2.#SORT/HARCY					
		RAD1=SQRT(1.+UABC) ' " " " "					•
		GL=2.*(RAD1-1./(1.+RAD))-ABC					
20 · ·		G(L)=GL, " -	tu ,	•			
		HL=1./SQRT(1.+6.2831846*RAD)				•	
• ,		H(L)=HL	1 4 11 11	'	,		
		HAL=(-1.+U/RAD1)*HL HA(L)=HAL	MARK 19800 1 2 2 2 217	·			
25	-	H8L=HAL+COSBL					
		H8(L)=HBL					•
	,	GMAX-AMAX1(GL, GMAX)					
	, -	HMAX#AMAX1(HL, HMAX)	· ·	,	#1 # BH1 P		
		HAMAX=AMAX1(AB\$(HAL), HAMAX)			•		
30		HBMAX=AMAX1(ABS(HBL), HBMAX)	44 4 4 44 14			•	
	. 20	CONTINUE					•
		GZ=GHAX-741 FZ=ALOG(HHAX)+GZ				,	
		GH-FZ+ALNLMX		,			
35		GZ=GZ+ALNLHX					
		GHA=GZ+ALOG(HAMAX)					
		GMB=GZ+ALDG(HBMAX)					
v1 w v	•	FS=0. " " " " " " " " " " " " " " " " " " "		4 2	•		•
4.6		FSA=0.			4		
40		FS8=0.	• • • • • •		h		
		DD 30 L=1,LHAX1	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,				
		GLH=GL-GM					
		GLMA=GL-GMA		<u></u>	-		
45		GLMB=GL-GMB					
		IF(GLM.GE674.) FS=FS+EXP(GLH)*H()	L) ·	•			
		TEICINA CE -474 1 ECI-ECIICUDICINA	AU 4 / 4 3				
		IF(GLHB.GE674.) FSB=FSB+EXP(GLHB))*HB(L)""""""""""""""""""""""""""""""""""""				
	30	CONTINUE					
50		WA=(HAHAX/HHAX)+(FSA/FS)	n				
		WB=(HBHAX/HHAX)+(FSB/FS)			_		
		RETURN		•	•		
		.,					

•	SUBROUTINE WAVGS	73/172 TS	•	FTN 4.6+452	05/18/79 13.53.19	PAGE	
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			UTES VARIOUS AVERAGES	OF MY Y MR OAFK O			
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		IMENSION DATUM (5)					
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			COSB(101), JNHAX, NC, NS,	ALMLMX)KIJMAX			
		MOTANCE CHAN'S	TUH(1)),(IBUHAX,LHAX1)	4 7 5 777 7 8		·- ·	-
	٠ _	0 30 8-1 5	•				
		00 10 K*1,5	,				
10							
		CONTINUE O 30 I=1,IBUMAX"			.,,	i	
		COSBUI=COSB(I)	enut o s de la company		A 446		
1 6		1U=QA*AMAX1(1.+B*C	12 80 1 3 0 4 1				
15		GQRQU2=2.*SQRT(QU) DO 20 J=1,JNHAX		., ,			-
		OU 20 JELFJAHAX					
		(CJ=NC(J) (SJ=NS(J)	,,,,,,,,,,			.,	-
		1=QU+NCJ+SQRQU2+NC.	ANC LANC LANC L		1		
20		CALL WAWB		4+	x		
20		ALL WAND				,	
		KAA-WAATHA KBA=WBA+WB		-			
		IDA=WDA+WD IA2A≠WA2A+WA+WA		•			•
_		182A=W82A+W8+WB ''					
25		162A=W62A+W6+W6					
. 23		ONTINUE ""		•		,	
		CNTINUE					
		00 40 K=1,5					
)ATUM{K}=DATUM{K}*:	TIMAY				
		CONTINUE	TOLIWY				
50		RETURN	•				
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APPENDIX B

EXPERIMENTAL SYSTEM DATA ACQUISITION

PDP-11/03 DRV 11 Parallel Line Unit signals which will be used:

Outputs: OUT ØØ through OUT 15*

Inputs: IN ØØ through IN 09*

NEW DATA READY*
DATA TRANSMITTED*

REQ A*· REQ B*

CSRØ*

Signals which will be generated by the data acquisition hardware:

BIT Ø through BIT 9*

START CONVERT*

STATUS*

CLEAR CONTROLLER*

TO SCAN IN (DECODE 33)*

t_S RECEIVED

COMPARISON MATCH*

COUNTER ENABLE

COUNTER DISABLE

ID RECEIVED ≠ ID REQUESTED

t_S • TO SCAN IN

ID RECEIVED = ID REQUESTED

t_S • TO SCAN IN

SØ through S5*

Signals which are expected from the BENDIX receiver:

t_R* Log Video(+)* and Log Video(-)*
ELevation*
AZimuth*

Signals which will be supplied from front panel switch: Basic Wide (BW) or Basic Narrow (BN)*

Quick Overview of Normal Operation

After initialization, the hardware will ask the PDP $11/\emptyset3$ to select the

Note: * indicates that the signal will be transmitted via the backplane of the VERO rack.

type of scan (Azimuth or Elevation), which should next be sampled. In response the PDP will read out the samples from the previously sampled scan which were stored in a semiconductor memory; then, the PDP will select the next type of scan to be sampled. This selection is referred to as "ID REQUESTED" (ID REQ).

Now, the hardware waits for the t_R signal from the BENDIX receiver which indicates the beginning of the next scan. (Note: t_R must come shortly after Bit 5 of the BARKER code (data Bits 1 through 5); however, scan function identification is associated with data bits 6 through 11. The current design assumes that Azimuth or Elevation scans are the only type being transmitted from the airport. If this is not the case design changes must be made. This problem will be discussed further in relation to the Function ID logic.) After receipt of the t_R pulse, the hardware waits for either the Azimuth or the Elevation line from the BENDIX receiver to be raised. This is referred to as the "ID RECEIVED" (ID REC).

If the ID requested is unequal to the ID received, then the hardware waits until the desired scan is received. When the desired scan—is received (ID requested = ID received), the hardware asks the PDP to tell it when to start sampling the TO scan. The PDP sends a 16-bit t word to the hardware. When a hardware timer operating at 3.84 MHz counts up to the t word, TO scan sampling commences. The t word measures time with respect to the t reference, but there are some delays which are involved which must be compensated for by adjusting the t word sent to the hardware. These adjustments will be discussed later.

The data samples have 10-bit resolution and are stored in a 256 x 12 semiconductor memory. After 33 samples are taken, the hardware asks the PDP to send a $t_{\rm S}$ word to tell it when to start FRO scan sampling. When the hardware timer counts up to this $t_{\rm S}$ word, FRO scan sampling commences. Then, 34 samples

are taken (the last one will be ignored when data are read out for processing).

Finally, the hardware returns to the state in which it asks the PDP to select the next type of scan to be sampled. The PDP reads out the 66 samples and sends out the next ID requested.

Detailed Description of the Data Acquisition Hardware

The detailed description will come in two parts. First, the hardware will be divided into functional units which will be described as separate entities. Second, a step-by-step description of the operation of the hardware will be given to show how the functional units interact by passing signals through the backplane of the VERO rack. The backplane wiring will be described after all of the functional units have been presented. The descriptions are most meaningful if they are read along with the logic diagrams of the hardware.

Functional Units

The hardware is divided into separate functional units, each of which has its own Vero Finger Board. These boards will be mounted in a Vero rack, and the backplane will provide the necessary interconnections from board-to-board and from the rack to the PDP 11/Ø3 computer. The functional units are:

- a. POWER SUPPLY
- b. OSCILLATOR (3.84 MHz Clock)
- c. A/D and Sample/Hold
- d. STATE CONTROLLER and FUNCTION ID LOGIC
- e. SCAN TIMER
- f. SAMPLE TIMER & BUFFER MEMORY

Power Supply (Figure B-1)

The power supply is a Datel Systems BPM 15/150-D5, which converts +5 volts to ±15 volts with COMMON. The supply has been mounted on a PC board with an aluminum plate for heat dissipation. Note: It is very important in a

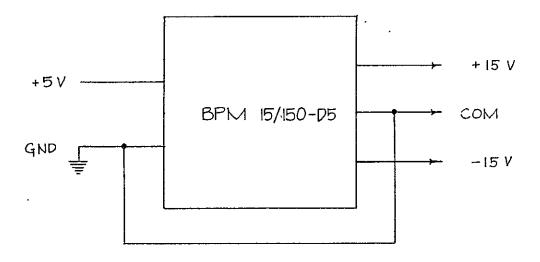


Figure B-1 Power Supply

system with both analog and digital signals present to maintain the correct distinction between analog and digital ground. However, these must ultimately be tied together -- preferably, as close to the power supply as possible.

Therefore, GROUND and COMMON have been wired together on the power supply board. [Note: second thoughts suggest the two supplies should be tied together at the A/D Converter (see below); this will be considered further]

Inputs: +5 Volts, GROUND Outputs: +15 Volts, -15 Volts, COMMON

Oscillator

The oscillator is a 3.84 MHz crystal oscillator which has been mounted on a special PC board which provides a ground plane underneath the entire unit.

Inputs: +5 Volts, GROUND Outputs: CLOCK

A/D and Sample/Hold (Figure B-2)

This board will include an AD509J Op Amp and an ADC1109 Analog-to-Digital Converter, both by Analog Devices, plus an SHM-12 Sample and Hold by Datel.

The op amp is used in the standard noninverting configuration, with high-frequency compensation, to provide a gain of four. This gain will boost the 0 - 2.5 Volts swing of the Log Video input to 0 - 10 Volts, which is the unipolar range of the A/D converter.

The board will operate as follows. The A/D converter will receive a START CONVERT command, via the backplane, from the SAMPLE TIMER & BUFFER MEMORY board. The converter will then raise its STATUS output signal, which will make the SHM-12 hold the current value of the Log Video input. Approximately four microseconds later, when the conversion is completed, the STATUS line will drop low. The 10 bits of digitized data are then valid. The negative-going edge of the STATUS signal will cause the 10 bits to be written into the buffer memory via the backplane. Note: While the schematic diagram for this board shows the

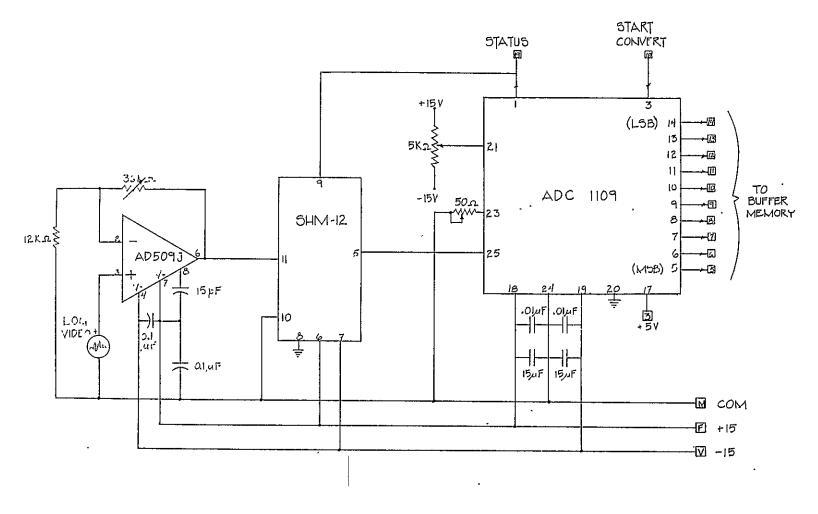


Figure B-2 A/D and Sample/Hold

ADC 1109 with trim pot adjustments for the zero adjust (Pin 21) and the gain adjust (Pin 23), these should be replaced ultimately with precision resistors. Also, it is assumed that Log Video will be brought to the backplane from the BENDIX receiver through a shielded cable.

Inputs: +5 Volts, GROUND, +15 Volts, -15 Volts, COMMON, START CONVERSION, Log

Outputs: STATUS, Bit 1(MSB) through Bit 10(LSB)

State Controller and Function ID Logic (Figures B-3 and B-4)

The state controller design is based on the control-state counter, presented in Section 5.11 of Thomas R. Blakeslee's book, <u>Digital Design with</u>

Standard MSI and LSI. The controller consists of two 74151 data multiplexers,
a 74193 presettable binary counter, and a 7442 demultiplexer. The inverters on
the outputs of the demultiplexer are used for buffering and also establish positive logic; thus, when a line, such as S1, goes high, the controller is in
State 1. The operation of the controller is discussed in Blakeslee's book and
will not be described here. However, we may summarize its performance with the
state diagram on the following page (Figure B-3).

The signals which cause the transitions from one state to another are produced at several different points in the data acquisition system:

Signal	Origin
CLEAR CONTROLLER	SAMPLE TIMER & BUFFER MEMORY LOGIC; the signal goes high at initialization when CSRØ is raised and, also, after FRO scan sampling.
NEW DATA READY	PDP 11/Ø3 DRV 11; this signal is raised when the DRV 11 places data in its output buffer. The data in this case is a code indicating the type of scan which the computer wants to sample next.
	BENDIX receiver.

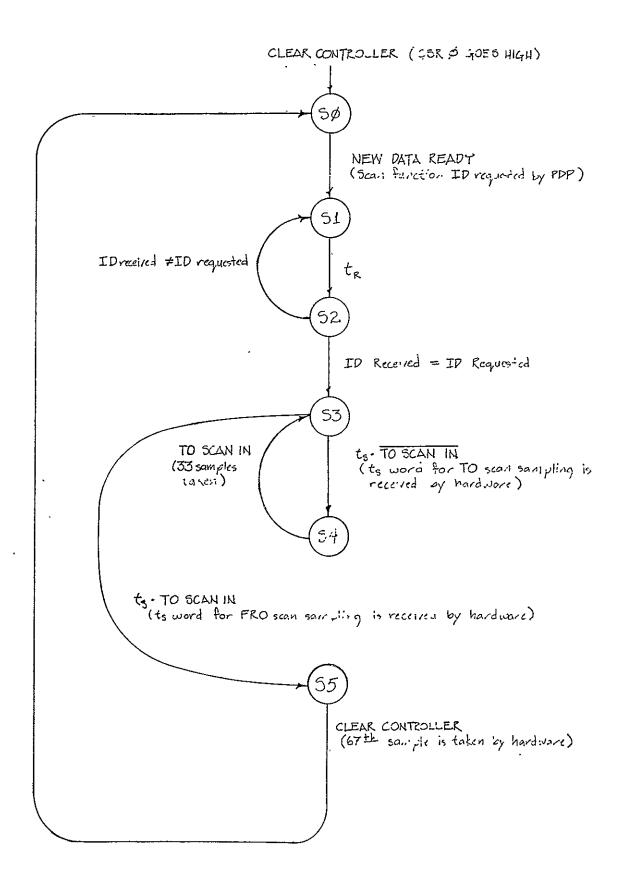


Figure B-3 State Diagram for State Controller

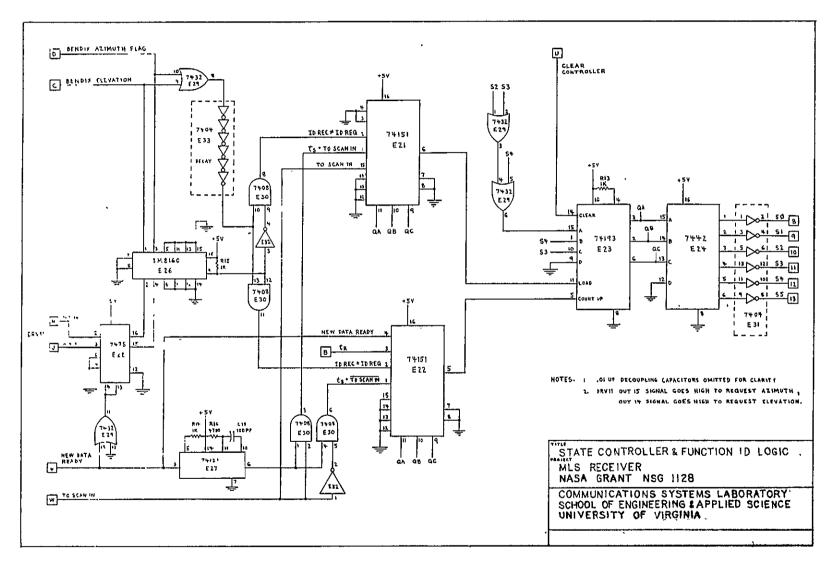


Figure B-4 State Controller and Function ID Logic

<u>Signal</u> <u>Origin</u>

FUNCTION ID LOGIC; these signals are produced on the same board that contains the state controller. The Function ID logic is discussed

below.

SAMPLE TIMER & BUFFER MEMORY LOGIC; after 33 samples have been taken, this signal is raised to indicate that TO scan sampling is completed.

ts · TO SCAN IN

TO SCAN IN

STATE CONTROLLER & FUNCTION ID LOGIC; when the PDP sends out the first ts word, the NEW DATA READY signal is pulsed to indicate that data is in the DRV 11 output buffer. The TO scan samples have not yet been taken, so TO SCAN IN is true. We use the trailing edge of the NEW DATA READY signal to fire a one-shot, whose output is logically ANDed with TO SCAN IN to produce ts • TO SCAN IN. By using the trailing edge, we insure that the data is stabilized in the output buffer before we accept it as valid.

ts . TO SCAN IN

Similar to above; however, when the PDP sends out the \underline{second} t_S word, TO scan sampling has already been completed and TO SCAN IN is true. Thus, TO SCAN IN and TO SCAN IN are used by the hardware to differentiate between TO and FRO scans.

Function ID Logic (Figure B-4)

As mentioned in the quick overview, the function ID logic, as currently designed, will work only if Azimuth and Elevation scans are the only scans being transmitted from the airport. The logic works as follows. When making an ID request, the computer will use signals OUT 15 and OUT 14 of the DRV 11.

OUT 15 will be raised to request Azimuth; OUT 14 for Elevation. The NEW DATA READY pulse associated with this output will strobe the request into a 7475 buffer latch. Now, when the BENDIX receiver decodes the scan function ID, either the Azimuth flag or the Elevation flag will be raised. A DM8160 comparator will compare the ID received with the ID requested. It takes approximately 20 nsec for the comparator output to become valid. In order to prevent premature generation of invalid ID RECEIVED # ID REQUESTED or ID RECEIVED = ID

REQUESTED signals, the rising edge of either the Azimuth or Elevation flag is passed through a delay line and is used to gate the comparator output and its complement on to the state controller. Thus, both of the signals ID REQUESTED # ID RECEIVED and ID REQUESTED = ID RECEIVED remain low until the comparator output is valid, at which time only one of the signals goes high. This is necessary for the correct operation of the state controller (see Figure B-5).

If the airport were to broadcast more than just Azimuth and Elevation scans, the hardware as currently designed would not work. The BENDIX receiver would have to send out a $t_{_{\mathrm{R}}}$ pulse at the beginning of each scan as it decodes the BARKER code; it has no way of knowing if the scan to follow is Azimuth, Elevation, or otherwise. Upon receipt of the tp pulse, the state controller would enter STATE 2. Now, however, the controller would be stuck if neither the Azimuth nor Elevation flags were raised, as neither of the signals ID REC = ID REQ or ID REC \neq ID REQ would be enabled to take the controller to another state. There are two ways around this problem. One solution would be to have the Bendix receiver provide additional flag signals for the other-scans and to expand on the current design using some of the extra inputs to the DM8160 comparator. The raising of any of the flag signals could be used to gate the comparator output on to the state controller. A second solution would be to obtain precise information about the delay between the output of the Bendix $t_{_{\mathrm{D}}}$ pulse and the output of the Azimuth or Elevation flags. Since the $\boldsymbol{t}_{\mathrm{p}}$ pulse starts a 3.84 MHz counter, logic could be designed around this counter to provide a pulse after this delay had elapsed. This pulse could be used to gate the comparator output on to the state controller.

Inputs: +5 Volts, GROUND, CLEAR CONTROLLER, TO SCAN IN, CLOCK

BENDIX t_R , Azimuth, Elevation NEW DATA READY, OUT 14, OUT 15

Outputs: S\phi, S1, S2, S3, S4, S5

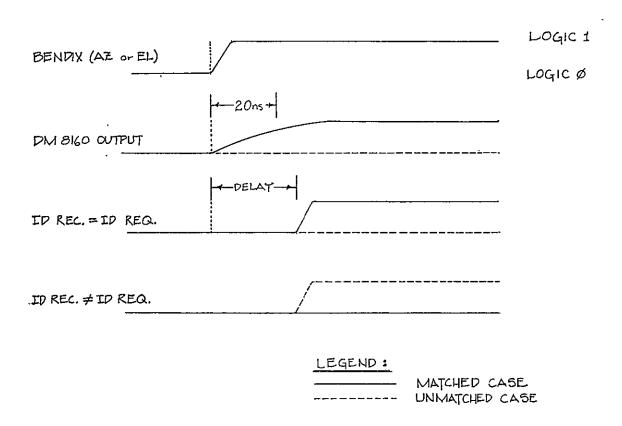


Figure B-5 Timing Diagram for Function ID Logic

Scan Timer (Figure B-6)

The purpose of the scan timer is to initiate sampling of the TO and FRO scans at the times specified by the 16-bit t_s words sent from the PDP. The scan timer uses four 7475 four-input latches to hold the t_s word. Four 7493 binary counters are wired to provide a 16-bit binary counter. The combination of a DM8130 10-bit comparator and a DM 8160 6-bit comparator will be used for a 16-bit comparison between the latches and counters. Cross-coupled NOR gates are used to implement classic Set-Reset flip-flops. Two flip-flops are used and will be referred to as the clock flip-flop and the comparator flip-flop. The clock flip-flop controls the flow of the 3.84 MHz clock signal to the binary counter. The comparator flip-flop controls the passage to the backplane of the ANDed comparator outputs (referred to as COMPARISON MATCH).

The scan timer will operate as follows. When the state controller enters STATE \emptyset , both flip-flops are reset. This will prevent the counter from being incremented and will disable the COMPARISON MATCH signal from reaching the backplane. When the controller enters STATE 1, the binary counter is cleared. Now, upon receipt of the BENDIX t_R pulse, the state controller enters STATE 2. This sets the clock flip-flop, and the binary counter begins counting at 3.84 MHz. If the ID received \neq ID requested signal is produced by the function ID logic, the controller re-enters STATE 1; and the counter is again cleared. It will remain cleared as long as the controller sits in STATE 1, even though the 3.84 MHz clock signal still flows to the counter input. On the other hand, if the ID received = ID requested signal is produced, then the controller enters STATE 3. Note that the t_S word has not yet been loaded into the latches; therefore, any matching between the counter and the latches cannot be valid. So STATE 3 is used to reset the comparator flip-flop, preventing the COMPARISON MATCH signal from being raised.

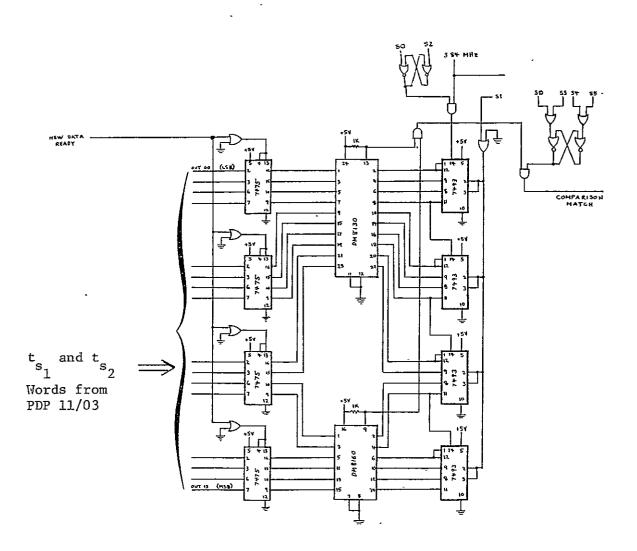


Figure B-6 Scan Timer Logic

STATE 3 is used to signal an interrupt request (REQUEST B) to the PDP. In response, the PDP will output a 16-bit t_S word which indicates when TO scan sampling should start. As mentioned in the quick overview, this t_S word will measure time from the t_R pulse but must be corrected for a constant delay time which will be discussed in the next section. The NEW DATA READY signal associated with the output of the t_S word is used to strobe the 16 bits into the 7475 latches. The trailing edge of the NEW DATA READY signal is used to generate the t_S . TO SCAN IN signal which will make the controller enter STATE 4. At this point, the latches contain a valid t_S word; so STATE 4 is used to set the comparator flip-flop. Now, when the counter counts up to the t_S word, the comparator outputs go high. The comparator flip-flop is set; thus, the COMPARISON MATCH signal is raised. This signal is passed via the backplane to the SAMPLE TIMER & BUFFER MEMORY board and enables sampling to commence.

After 33 samples have been taken, the state controller re-enters STATE 3. The Request B line to the PDP is raised to request the FRO scan t_s word. Since the t_s word has not yet been received, STATE 3 resets the comparator flip-flop to prevent the COMPARISON MATCH signal from going high. When the t_s word is received, the t_s . TO SCAN IN signal will make the controller enter STATE 5. STATE 5 sets the comparator flip-flop to allow the COMPARISON MATCH signal to go high. Meanwhile, the counter continues to count at 3.84 MHz. When it counts up to the FRO scan t_s word, the comparator outputs again go high; and the COMPARISON MATCH signal is raised. This allows FRO scan sampling to commence. After the 67^{th} sample is taken, the controller returns to STATE \emptyset .

Inputs: +5 Volts, GROUND, OUT ØØ(LSB) through OUT 15(MSB), New Data Ready,

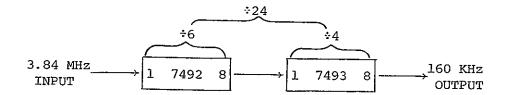
CLOCK, SØ through S5

Output: COMPARISON MATCH

Sample Timer and Buffer Memory (Figure B-7)

The purpose of this board is to control the operation of the A/D and Sample/Hold board and to store the samples as they are taken so that they may be read back by the PDP 11/Ø3. Three Intel 2101 256 x 4 Static MOS RAM's provide the memory storage. Although only 66 samples with 10-bit resolution need to be stored, space is at a premium on the VERO boards and the 2101's provide the necessary storage with only three 22-pin I.C. packages. The samples are taken at a rate of 160 KHz. This frequency is obtained from the 3.84 MHz clock by a divide-by-24 counter which consists of the series combination of a 7492 counter and a 7493 counter. The memory address logic for 2101 RAM's is provided by an 8-bit binary counter consisting of two 7493 counters. These will be referred to as the address counters. Additional logic is wired to the outputs of the address counters to provide signals which go high when the counters point to the 33rd and to the 67th locations in memory. This additional logic consists of two 7421 dual 4-input AND gates along with some inverters and 7408 AND gates.

NOTE: As was mentioned previously, the t_s words sent by the computer to the SCAN TIMER must be adjusted for a constant delay factor. This delay is due to two primary sources. One source of delay is the divide-by-24 counter.



A detailed analysis of the operation of this counter, based on its internal logic, yields the following result: the counter provides

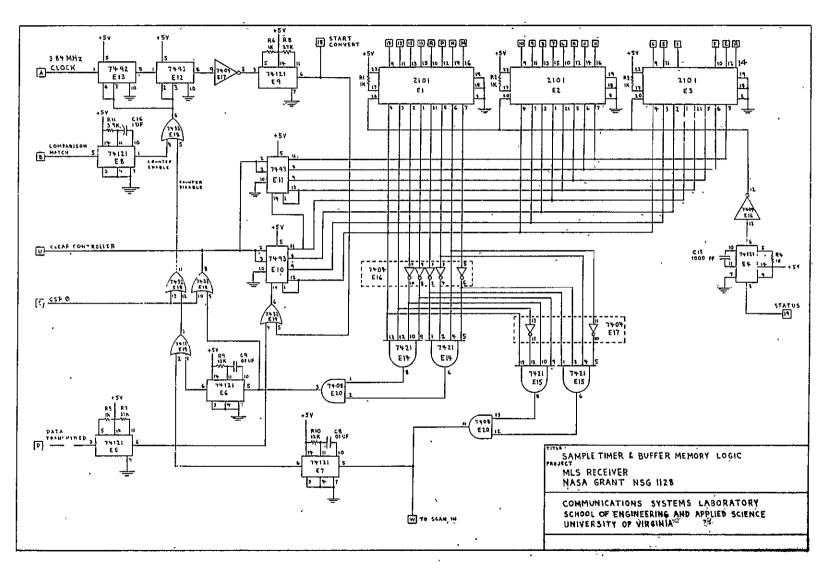


Figure B-7 Sample Timer and Buffer Memory

the proper frequency division, but the output is shifted in phase. The first output pulse comes at the end (trailing edge) of nine input pulses. At 3.84 MHz, this delay is approximately 2.34 microseconds.

A second source of delay will be the Bendix receiver. The receiver is to output the leading edge of its \mathbf{t}_R pulse no later than 100 microseconds after reception of Bit 5 of the five-bit Barker code. The actual delay will have to be obtained from Bendix. Note that this delay will be compensated for partially or wholly by the delay in transmission of the Log Video envelope.

Other delays associated with gating and signal propagation are measured in nanoseconds and are insignificant when compared to the sources of delay above. Thus, the total delay may be expressed as:

TOTAL DELAY=(COUNTER DELAY)+(BENDIX t_R DELAY)+(BENDIX Log Video DELAY)

This total delay must be subtracted from the $t_{\rm S}$ words which are calculated by the computer before they are sent to the SCAN TIMER board.

The sample timer and buffer memory board will operate as follows. During the initialization following power-up, the computer will raise and then lower the CSRØ signal of the DRV 11 Parallel Line Unit (DRCSR Bit Ø). This pulsing of CSRØ will do three things: (1) it will raise the CLEAR CONTROLLER signal, thus placing the state controller in STATE Ø; (2) it will clear the divide-by-24 counter: (3) it will clear the address counter so that it points to memory location zero of the buffer memory.

Now, STATE Ø is the state in which the computer reads out the samples from the previously sampled scan. It does this by repeatedly reading the contents of the DRV 11 input buffer, DRINBUF. After each read operation, the DRV 11 automatically pulses the DATA TRANSMITTED signal. This signal will be used by the hardware to increment the address counter so that the next sample may be read. Thus, to read out the 66 samples the computer must do the following. First, it must read DRINBUF once and ignore this sample. This sample, stored in buffer memory location zero, is actually the 67th sample and that is why it is ignored. The 66 samples of interest are stored in Locations 1 through 66. So the computer now does 66 successive reads to obtain the 66 samples. The data is in the lower 10 bits of the 16-bit input buffer, with Bit Ø as the Least Significant Bit.

After the 66th sample has been read (67 read operations), the hardware automatically clears the address counters in preparation for the next set of samples to be taken. The hardware also raises the CLEAR CONTROLLER signal (this has no effect here since the controller is already in STATE Ø) and fires a one-shot (the purpose of the one-shot will be explained later).

No more activity occurs on the board until the COMPARISON MATCH signal from the SCAN TIMER board is raised, signifying that sampling is to begin. The COMPARISON MATCH signal is fed into a one-shot (E8). The output of this one-shot, labeled COUNTER ENABLE, is normally high and is used to prevent the divide-by-24 counter from incrementing. When COMPARISON MATCH goes high, COUNTER ENABLE goes low for an interval somewhat longer than the time necessary to take 33 samples at 160 KHz. Thus, the divide-by-24 counter is allowed to start incrementing. Each output pulse of the counter fires a one-shot whose output is the START CONVERT signal. This signal causes the A/D and Sample/Hold board to take a sample and also increments the address counter so that it

addresses the location in the buffer memory where the sample will be stored. When the A/D conversion is completed, the STATUS line goes low. This transition fires a one-shot (E4) which provides a low-true write pulse for the buffer memory. The 10-bit digitized sample is thus written into the buffer memory at the address indicated by the address counters.

When the 33rd sample is taken, logic wired to the outputs of the address counters decodes the 33 and raises the TO SCAN IN signal. A one-shot (E7) is fired which raises the COUNTER DISABLE signal. This signal remains high for the duration of the TO scan and clears and disables the divide-by-24 counter, thus preventing any more samples from being taken during the scan. The raising of TO SCAN IN takes the state controller back to STATE 3.

The board is now inactive until the COMPARISON MATCH signal goes high, signifying that sampling for the FRO scan must begin. The COUNTER ENABLE signal goes low, and samples are taken and stored as before. However, during the FRO scan, 34 samples are taken, the last of which will be ignored. This is done so that the 66 samples of interest will be stored in consecutive memory locations, while still providing a self-clearing address counter. Thus, when the 67th sample is taken, logic wired to the outputs of the address counters decodes the 67 and clears the address counter so that the 67th sample gets written into memory location zero. A one-shot (E6) is fired whose output raises the COUNTER DISABLE line, thus preventing anymore samples from being taken during the FRO scan. The CLEAR CONTROLLER line is also raised, so the state controller is sent back to STATE Ø.

STATE \emptyset is used to signal the PDP $11/\emptyset3$ with an interrupt (Request A). The PDP responds by reading out 67 samples (ignoring the first) and then by sending out the code for the next type of scan to be sampled.

Note: The Basic Wide/Basic Narrow option will be transmitted to the

buffer memory from a front panel switch. The option will be stored in memory along with the data samples and may be checked by looking at Bit 15 of the input buffer after any of the data samples have been read.

Inputs: +5 V; GROUND, Bit Ø(LSB) through Bit 9(MSB), BW/BN, COMPARISON MATCH, CLOCK, STATUS CSR Ø, DATA TRANSMITTED

Outputs: START CONVERT, TO SCAN IN, CLEAR CONTROLLER, IN ØØ(LSB) through IN Ø9(MSB), IN 15

Backplane Wiring

The table on the following page gives terminal pin assignments for each of the VERO FINGER BOARDS which will be used to implement the functional units described above (Figure B-8).

II. Step-by-Step Operation

We may now summarize and clarify all of the previous discussion by giving a step-by-step description of the operation of the data acquisition hardware. The state transitions of the state controller will provide a convenient outline structure for the description.

Power Up

During the initialization following power-up, the computer must pulse the CSR Ø signal. On the sample timer and buffer memory board this pulse will clear the divide-by-24 counter and the address counter and will also raise the CLEAR CONTROLLER signal. The CLEAR CONTROLLER signal is transmitted to the state controller and function ID logic board, where it places the state controller in STATE Ø.

State Ø

The STATE \emptyset line is connected to the Request A line of the DRV 11; so

POWLK SUPPLY	OSCILLATER	ND and Sample / Hold _	Function . 29 Logic	Scan_Timet	Sample Tomer &		
	·	1:	1	1	- 1-6/-bH		
<u> </u>		- 1	1-)	 - }	- *- <i> </i>		
5 + 5 Volts	_ <u> \$ + 5 _ Yel</u> te	3.{_+5_Yalts	3- 25 Yolis	2 } J.5 . Volta	. 2 2 1 5 Yelta		
<u>.)</u>	<u> + J</u>	_ • <i>.</i>	 -/	<u> -</u>	 \]		
<u> </u>		3_ b1(MSB)}	ļ	s	2 8:1 2 (M2H)		
s			L HEW DATA READIL	C HEM DITA PEAN	6 6 1 8		
T	. 7/	7 8.1	7	,	7 2,17		
·	1	3 Est	3 56	9 56	5 5:16		
·	•	2 Col Seffer	9 51	1 51	8,15		
·	10	lu B+	10 52	10 52	lu 8.+ 4		
		11 Byt -		0 53	u 9.1 3		
		1	1				
	. 11		111 54	12 95	1 1		
<u>n</u>		113 847	10. 22	<u>19 55</u>	in Brt 1		
H	. **	17 Bit (LSB)	154	17	1 61 0 (cs)		
· } · · · · · · · · · · · · · · · · · ·	<u>"}</u>		1	15)	1,5		
C GROUND	K GPOUND	GROUND	L > GROUND	IS GROUND	16 GPOUND		
,)			<u>i., j </u>	<u></u>	<u>'n</u>		
3		IS START CONVERT	lu.	15	11 START CONVERT		
·	_19	i STATUS		13	19 STATUS		
te.	16	10	10	140] 		
··	11 CLOCK	131	in crock	11 CLOCK	1 CLOCK		
· · · · · · · · · · · · · · · · · · ·	7	Ţ <u>.</u>		22	171		
			İ.	ľ.			
	1	h reg video (+)	1	,	A 124 15 (Rules to 10		
			I STHENY THE	B COMPACION MATCH	†·		
	i° .	. c Log Yides (-)	C BEHDIX ELEVATION	c OUT #5 (158)	٠ .		
	D		B REMPIX AZIMUTH	1 00.5	P. DATA TRANSMITTE		
	· · · · · · · · · · · · · · · · · · ·	<u> </u>	!	£ 0vT 62	E 141 CP (120)		
2+15-Y-11+		ir +15 Volts	<u>'</u> F	F 0VT.07	F 14 C1		
	<u> </u>	<u> </u>	RESULTED	N CUTON	U 18 C7		
L		¦	A OUT IS RESOLUTE	1_CVT.05	1 1966 I		
	<u>.</u> *	_ 	ļ	K crt ds	· K 14 ds1c 1		
				L CUT ST T MA	1 1N Ch		
1_COMMON	<u>n</u>	M COMMON	. <u>n</u>	m out or from	m pt 03		
	!	J,	! ₁₄	M_CaT_C3ccm_alex	K NCL		
	•	' ,	, <u>.</u>	P_cut_10	· 1		
,	1	i a	1	S Cultur	E THES CHEST I		
		,	i,	5 MT 6	5 564		
	~	ļ.,	-		I.		
· · · · · · · · · · · · · · · · · · ·	······································			I .0.1.15			
	1	l .	'n CffVK cañz sórif y '	K CIT IF.	n crive composite		
- 15. Valta	<u></u>		, v	A CCT 12 (615)	 		
·	· · · · · · · · · · · · · · · · · · ·	·- *	W TO SCAN IN	W	W. TO_SLAN IN		
·	<u>;</u>		x	×	×		
·	7		X	y	1		
t	-		·	t	lr		
		_ L	L				

Figure B-8 Terminal Pin Assignments

when STATE Ø occurs, an interrupt is generated. The STATE Ø signal also is transmitted to the scan timer board, where it resets the clock flip-flop and comparator flip-flop, thus preventing the COMPARISON MATCH signal from being raised.

Response to Interrupt Request A

The computer must respond to the Request A interrupt by reading its input buffer 67 times. The first read will be ignored and is used merely to increment the address counter so that it points to buffer memory location one, which holds the first sample. The DATA TRANSMITTED signal generated by each read operation is transmitted to the buffer memory to increment the address counter.

After reading in the samples, the computer will send out a code for the type of scan that it wants to have sampled. To request Azimuth the OUT 15 signal will be raised; to request Elevation the OUT 14 signal will be raised. The NEW DATA READY signal generated by this output will latch the ID requested on the STATE CONTROLLER & Function ID Logic board and will take the state controller to STATE 1.

State 1

The STATE 1 signal is transmitted to the scan timer board, where it clears a 16-bit binary counter which will operate at 3.84 MHz. Now, the controller waits until the Bendix receiver generates a t_R pulse. This pulse will take the controller to STATE 2.

State 2

The STATE 2 signal is transmitted to the scan timer board, where it sets the clock flip-flop. This makes the 16-bit binary counter begin to count at 3.84 MHz.

Meanwhile, the Bendix receiver will be decoding the function ID of the current scan. It will raise either the Azimuth or Elevation flag. The function ID logic, in turn, will generate either the signal "ID received \neq ID requested" or the signal "ID received = ID requested." If ID rec \neq ID req is generated, the state controller goes back to STATE 1, thus stopping and clearing the 16-bit counter. If ID rec = ID req is generated, the state controller goes to STATE 3.

State 3

The STATE 3 line is connected to the Request B line of the DRV 11; so when STATE 3 occurs, an interrupt is generated. The STATE 3 signal is also transmitted to the scan timer board, where it resets the comparator flip-flip, thus preventing the COMPARISON MATCH signal from being raised.

Response to Interrupt Request B

The computer must respond to the <u>first</u> Request B by sending out a 16-bit t word (with adjustments as noted before) which tells the hardware when to begin TO scan sampling. In response to the <u>second</u> Request B (STATE 3 is generated twice), the computer must send out a 16-bit t word which tells the hardware when to begin FRO scan sampling.

If the TO scan has not been sampled, then the TO SCAN IN signal from the sample timer board will be low. The state controller board will use the trailing edge of the NEW DATA READY signal associated with the first t_s word output to generate the signal t_s . TO SCAN IN; this signal will take the controller to STATE 4.

On the other hand, if the TO scan has already been sampled, then the state controller board will generate the signal $t_{\rm S}$ • TO SCAN IN; this signal will take the controller to STATE 5.

State 4

The STATE 4 signal is transmitted to the scan timer board, where it sets the comparator flip-flop, thus allowing the COMPARISON MATCH signal to go high when the 16-bit counter counts up to the TO scan t word. When the COMPARISON MATCH signal is raised, sampling begins as described in Section I. After 33 samples have been taken, the TO SCAN IN signal from the sample timer board is raised. This signal takes the state controller back to STATE 3.

State 5

The STATE 5 signal is transmitted to the scan timer board, where it sets the comparator flip-flop, thus allowing the COMPARISON MATCH signal to go high when the 16-bit counter counts up to the FRO scan t word. When COMPARISON MATCH is raised, sampling begins as described in Section I. After 34 additional samples have been taken, the sample timer board raises the CLEAR CONTROLLER signal, which takes the state controller back to STATE Ø.

Test Program

The computer program used to test the completed data acquisition system is shown in Figure B-9.

```
DATA INTERFACE
                                                 WITH CONTRILLER
                                   PAGE !
.MAIN. RT-11 MACRO VM02-12
                                                             TUST
          000000
                           · ASECT
                                                              5/10/76
                                    167770
          167770 DACSH
3
          167772 OUTBUF
                                    167772
                                    167774
4
5
          167774 INBUF
                           -MCALL
                                    -REGDEF
                           .REGDEF
6 000000
7
                                    1000
                           RESET
                                                      : INITIALIZE
8 001000 000005
9 001002 012706
                           MOV
                                    #1000.SP
          001000
                           MOV
                                    #1.DRCSR
10 01006
          012767
          96999
                                    # 0. DRCSR
11 01014 012767
                           MOV
          000000
          166746
                           BIT
                                    .200. DRCSR
                                                      ; WAIT FOR REO A
12 01022 032767 A:
          000200
          166740
13 01030 001774
                           BEQ
                                    INBUF, RØ
                                                      ; BRING IN SAMPLES
                           MOV
14 01032 016700
          166736
                           моч
                                    #BUFFER, RO
15 01036 012700
          002000
16 01042 016720 B;
                           MOV
                                    INBUF, (RØ)+
          166726
                                    #BUFEND, RO
                           CMP
17 01046 022700
          002204
                           BNE
 18 01052 001373
                           HALT
 19 01054 000000
                                    FUNC, OUTBUF
                                                      SOUTPUT FUNCTION
20 01056 016767 C:
                           MOV
          166706
21 01064 032767 D:
                           BIT
                                    #100000, DRCSR
                                                      WAIT FOR REG B
          100000
                           BEQ
22 01072 001774
                                    TS1, OUTBUF
23 01074 016767
                           MOV
                                                      COUTPUT TS1
          001702
                                    #100000 DRCSR
                                                      ; WAIT FOR REQ B
24 01102 032767 E:
                           BIT
          166666
25 01110 001774
                           BEQ
                                    TS2, OUTBUF
                                                      ;OUTPUT TS2
26 01112 016767
                           MOV
          166652
                           BR
                                                      REPEAT
27 01120 000740
28
29 Ø2ØØØ
          002000
                                    2000
                  BUFFER:
                           -BLKW
                                                      ; DEFINE 66 WORD PLOCK
30 02204
31
                  BUFEND:
                                    3000
          003000
32 03000 000000 FUNC:
33 03002 000000 TS1:
                                                      DEFINE PARAMETERS
                            .word
                           .WORD
                                    0
                                               TS1 - 4 msec z 1544 \phi_{10} = 3612\phi_{\gamma}
34 03004 000000 TS2:
35 000001'
                            - LND
                                               TS3 = 11 msec \frac{2}{4246} 4246\phi_{10} = 12273|_{\gamma}
 SYMBOL TABLE
                                                      BUFEND 002204
         001022
                                    001042
 BUFFER
                                    001056
DRCSR = 167770
INBUF = 167774
                                                      FUNC
                                    001102
                                                               993999
                                                      PC
R2
R5
                            OUTBUF=
                                    167772
       = $666666
 КØ
                           R1
                                  = 1000001
                                                             = 10000002
 SP
       = 2000006
                                    003002
                                                      TS2
                                                               003004
         993996
 . ABS.
00000 001
ERRORS DETECTED: 0
FREE CORE: 1707. WORDS
MLSTES, WLSTES=MLSTES
 ?*E0F*?
```

Figure B-9 Data Acquisition System Test Program

APPENDIX C

A 6D LOE OPTIMAL RECEIVER

In this design, a 6th component, $\hat{\omega}_{sc}$, is appended to the definition of $\hat{\gamma}$, requiring basically only two changes:

1. Appending a 6th row to matrix $D(\hat{\gamma})$ so that instead of (2.103) it now reads

where, as indicated in (3.10a), the quantity

$$\hat{\beta}_{j} = \hat{\beta} + \hat{\omega}_{sc} \tau_{j}$$
 (C-2)

is one which has already been in use in the SD LOE (see PLOPT, Appendix A) (in spite of the assumption (2.90) used in the derivation of the LOE that all the β_i are equal); and

Changing the dimensions of all affected arrays in the programs,

Both changes affect module PLOPT, the latter additionally affects modules MLSSIM, OPTRVR and CTLACQN, the (interference acquisition) version of CONTRL which was selected for this study. Listings of the modified versions of these modules, CTLACQ6, MLSIM6, OPRVR6 and PLOPT6 follow below. Two options of this basic design were provided in the programs.

- 1. $N_s = 8$, and the state vector x is as defined for the Optimal design;
- 2. $N_s = 9$, and an additional component, $\dot{\omega}_{sc}$, is appended to the end of the state vector definition.

It was not possible to run any simulation studies involving the 6D LOE, the computing resources having practically been exhausted at this point (including the \$4700 University grant); as a debug exercise, however, the programs, by parameter inputs, were specialized to the prior SD LOE OPTRVR design and an earlier interference acquisition run with OPTRVR duplicated.

SUBROUTIN	E CONTR	73/172	τς		FTN 4.6+452	05/18/7	79 13.43.29	PAGE	1
		SUBROUTINE CO	HTRL(ISW)		,	, by My P Brack and I	DI MANDOO EELA DO. AS MIELOS D		
5			E MLS SIMULATION ISITION SCENARIO		•	No.			•
		REAL LAMDA "	/21. VNAUC/21. NA	, TIN(A) - DATOUT(A) -	. nout		·		
	- **	INTEGER YNAMI	(2) YNAM2(2) YN.	TIN(4),DATOUT(4), AM3(2),YNAH4(2),\			4 A 444 AV	•	
-10			N, NOLDE, NOAC, KAI	AH9(2),STITLE(9) LHAN,LOE,TETHRD,}	HORE, NFIRST, ADAPT	(A 122)		-	
·		COHMON/IDDATA	/ISIH, IPHLS, IŖC	VR. IADAP, ITETHR'S	IPOPT				
. п		COMMON/RCVR01	/THAMAX,THAMIN, /NGHIN,NGHAX,DE	LBL, NGM, IR, IAE			** - * 1		
.15				RO,BO,WSCO,NSO(6) (4),FSAMP,K,KM,TI				• • • •	
				T(9,9),H(6,9),IC(DAC,GAMES(6),RDI/					
20		COMMON/RCVRO6		(6,6),PHI (6,6),PA					
		COMMON/RCVRO8	/XSLOE(9), ESLOE /BRCVR, BB, PDCRI						
		COHMON/RCVR10	/XS1(9),XS(9)		T.B.UCC.UCCDOT		- Transpires you a mark in a National		
25		COMMON/HLS001	/CSNRT, CSNRF, DS	T,ALFAR,THR,THRDO NRD8,RHD,BETA,FS(
		COHMON/HLSOO3		10(4) DELTAT(2),	XD(9,2),YO(4,2)	_		_	
	,	DIMENSION ION), IDENTS(6), RHSV					
. 30		DIMENSION EAL DIMENSION	FA(100), ETHET(1 X(9),	OO),EALFR(100),ET Scanni		.00)			
	-,	DIMENSION EBE DIMENSION EFS	TA(100),EFSC(10 CDT(100)	0)	•			•	
				M,[DNRS(1)),(DOU? FIRST/.FALSE./,AU			4e bs b e e	•	
		DATA DATIN/10		500000F000,2 *0 /~		***		,	•
		DATA IDASCI/7	HCROSSMP.7HRMSE	(T),7HRMSE(B),7HF S1 ,8H PMLS2 ,	RMSE(F),7HACQSITN	ł,	- 1 \		
40	*	8H PHLS3 . BH	THRHLD ,8H OPT	IML .8H SUBOPT .6 ERED.2H .8H POPT	BH -3 DB ,8HADAP	TIV ,			
. ,,		8H POPT3 / '		ART/26/aFILOUT/a				,	
	0	FILEIN/.FALSE	•/		THE DESIGNATION OF THE PERSON				
. **		DATA GOGT88/7	HAZIMUTH,7HELEV .3/,GQGT99/1.E4	<i>1</i>	, , ,				ı
	~ ~ 0	6HTHROOT,6H 1	B , 6H WSC , 6	,6HTHEDOT,6HALF, HWSCDOT/	.,,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			•
50		DATA YNAM1/8H	EALFA #8H '	BER /, YNAM2/8H /, YNAM3/8H E/	ALFAR ,8H	<i>i</i>			
		DATA YNAN7/8H	EABSBETA, 8H DEG		RНО , ВН				
, , ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			EABSESC .8H HE EABESCOT.8H HZ/			***************************************		-	
55	C		0+300+400,500,6	00,700,800,900,10	000,1100,1200),IS	SW			
	1	FORMAT(1H)				*2	4 4 1	•	

SUBROUTIN	E CONTRL 73/172 TS PAGE 2" FTN 4.6+452 " "05/18/79 13.43.29 " PAGE 2" "
	10 FORĤAT(9(/))
	II FORNAT (IHI)
60	C
***	C+++++++++++++++++++++++++++++++++++++
	C CONTINUE
	C THIS IDENTIFIES THE SCENARIO AND REINITIALIZES, AS NECESSARY,
65	CTHE FOLLOWING RECEIVER PARAMETERS
••	CSIGMA, IAE, DSNROB, RHO, FSC, BEYA, M, BMLS
	IF(NFIRST) GO TO 155
	NOAC = • FALSE •
	NFIRST*•TRUE•
70	JBNAM=JDBNAME(1)
	1914#3
	IHOD#4
	WRITE (7,110) 110 FORMAT(34H1INTERFERENCE ACQUISITION SCENARIO/7H 6D LOE/)
75	IF (IRCVR.NE.1) GO TO 118
	NRITE (7,115)
~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~	115 "FORMAT (35H THIS IS NOT FOR THRESHOLD RECEIVER)
	STOP ≠ ABORTED→NOT FOR THORVR≠
	118 CONTINUE
. 80	CALL LOGIO(6HFILEIN, FILEIN, O)
	TLASURISTERMY WOINKING
	IF(.NOT.FILEIN) GO TO 122
	IX=IATTACH(6LTAPE15,DATIN)
gg	IF(IX.NE.O) CALL INTIC(6HIX(AT),IX,1,1) IF(IX.NE.O) STOPFINPUT FILE ATTACH NOT SATISFACTORY ' """" ' """"""
0	WRITE(7,120) (DATIN(I),1=1,2)
	120 FORMAT (23H THIS READS INPUT FILE , 2A10/)
	122 CALL LOCYOTERIOUT EYLOUT AL
	CALL INTIG(6HNSTART, NSTART, 100, 0)
90	NSTOP=NSTART
*****	CALL INTID(6H NSTDP,NSTDP,100,0)
	CALL LOGIO(6HTETHRD, TETHRO, 0)
	CALL LOGIO (6HADATY, ADAPTY, 0)
95	IF(TETHRD) ITETHR=2 IF(ADAPTV) 60 TO 135 TT TO TO THE TOTAL THE TOTAL TO THE TOTAL
,,	IRSIGN=1
	IRSIGN=1 IADAP=3
	128 CONTINUE
	7
100	IASC=3+(I-1)+IDNRS(I)+6
	TITE IDENTS(I)=IDASCI(IASC)
	145 CONTINUE
	= ENCODE(8,150,IDENTS(1)) IDASCI(ISIM),IHOD
	150 FORHAT(A7, I1)
105	WRITE (7,152) IDNRS, IHOD
	152 FORMAT (1H ,611-1X,11/)
	152 ENDMAT (10 AR)
	TO THE CALL INTIDION TO TRAIRAGADITE TO THE TOTAL TO THE TOTAL TO THE TOTAL TO THE TOTAL TOTAL TO THE TOTAL
110	CALL REALTO (6HRHOMAX, RHOMAX, D)
	CALL REALID (6HRHOMAX,RHOMAX,0) CALL REALID(6H DTHO,DTHO,0)
•	CATI DEALTHIAD TROPITABRIAN
	BETAD=BD+180./PI '
	F\$CO=W\$CO+1./(2.*PI)
,	

' " 'SUBROUTIN	CONTRL 73/172 TS FTN 4.6+452 05/18/79 13.43.29 PAGE
NOTE #	MULTIPLY BY 1 IGNORED
- "- 115	CALL REALIDIGH BETAG, BETAG, 0)
445	CALL REALIDIGH FSCO,FSCO,O)
•	IF (IR.GE.5) CALL REALID(6HGQGT8B,GQGT8B,O)
	IF (IR.GE.6) CALL REALID (6HGQGT99,GQGT99,0)
	80-86TAQ+PI/180.
120	WSCO*FSCO***PI
	NRUN-NSTART-1
	DSNRD8=20.
	8H0=0.5
	BETA=45.
	FSC=0.
	BMLS=1.
	BRCVR=1.
	THESEP=1.80
	FSCDOT=XO(9,1AE)*.5/PI
130	155 CONTINUE
	IF (FILEIN) GO TO 156
	NR UN ≠NR UN+1
	CALL INTIO (6H NRUN, NRUN, 1, 1)
135	CALL REALIO(6HDSNRDB,DSNRDB,O)
	CALL REALIG(6H RHO,RHO,0)
	- CALL REALIO(6H. BETA, BETA, BETA, DETA,
	CALL REALIO(6H FSC,FSC,O)
	IF(IR.EQ.6) CALL REALID(6HFSCDOT, FSCDOT, 0)
140	CALL REALID(6H BMLS, BMLS, 0)
	- CALL REALIDIGH BRCVR,
	CALL REALID(6HTHESEP,THESEP,0)
.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	CALL INTID(6HKSTART, KSTART, 100,0)
	GO TO 170
145	158 CONTINUE / The second seco
	READ(15,160) NRUN, DSNRDB, RHO, BETA, FSC, FSCDBT, BHLS, BRCVR,
	CTHESEP,KSTART
	IF(EDF(15)) 180,165
	IF(EDF(15)) 180,165 160 — FORMAT (15,8G10.3,15) 165 IF(NRUN.LT.NSTART) GD TO 158 — IF(NRUN.GE.NSTOP) MORE=.FALSE. 170 IF(NRUN.GE.NSTOP) MORE=.FALSE. — X0(3,1AE)=X0(6,1AE)=0. X0(5,1AE)=X0(2,1AE)=THESEP X0(9,1AE)=SCOOT*(2.*PI)
150	165 IF(NRUN.LT.NSTART) GO TO 158
	· · · IF(NRUN.GE.NSTOP) MORE=.FALSE. · · · · · · · · · · · · · · · · · · ·
	170 IF(NRUN.GE.NSTOP) HORE*.FALSE.
~ 4	XO(3, IAE) =XO(6, IAE) =Q.
	XO(5, IAE)=XO(2, IAE)=THESEP
155	XO(9, IAE) = FSCDOT*(2.*PI)
	GRETAR-ARCIRETAN-ARCIRETANI
	EFSCO+ABS(FSC)-ABS(FSCO)
	RETURN
	180 STOPEEDF REACHED ON INPUT FILE
160	C
	C*************************************
	C. C. C. C. C. C. C. C. C. C. C. C. C. C
	200 CONTINUE
	C THIS GUIPUTS BASIC SIMULATION DATA OF INTEREST, SUCH AS
165	CTHE ANGLE FUNCTION, INITIAL STATE, ETC.
***	WRITE (7,209)
	209- FORMAT(5H1NRUN, 4X, 6HDSNRDB, 7X, 3HRHO, 8X, 4HBETA, 8X, 3HFSC, 7X, 6HFSCDOT
	C,8X,4HBHLS,8X,5HBRCVR,6X,6HTHESEP,5X,6HKSTART)
	WRITE(7,210) NRUN, DSNRDB, RHO, BETA, FSC, FSCDT, BHLS,
170	CBRCVRYTHESEPYKSTART
	UPDATUS THERET LOS TUNE

SUBROUTIN	IE CONTRL ` 73/172 TS FTN 4.6+452 . 05/18/79 13.43.29 PAGE	4
	210 FDRHAT(1H0,14,8(2X,610.3),2X,14)	
	IF(*NOT.FILOUT) GO TO 245 IF(NRUN.LE.9) ENCODE(10,220,DOUT) IDNRS,1HU,IHOD,1HO,NRUN	
175	220 FORMAT(6I1,A1,I1,A1,I1)	
175	IF(NRUN.GE.10) ENCODE(10,230,DOUT) IDNRS,1HU,IHOD,NRUN 230 FORMAT(611,A1,11,12)	-
	IX=IREQST(6LTAPE17,3L*PF) IF(IX.NE.O) CALL INTIO(6HIX(RQ),IX,1,1)	-
180	IF(IX.NE.O) STOP#OUTPUT FILE REQUEST NOT SATISFACTORY# WRITE(7,240) (DATOUT(I),I=1,2)	
	240 FORMAT(25HOTHIS WRITES DUTPUT FILE ,2A10) 245 CALL DATE(TODAY)	
	WRITE (7,250) FUNCTN (IAE), IAE 250 FORMAT (1H0, A7, 15H FUNCTION (IAE=, II, 1H))	
185	X(4)=XO(4, IAE)=O.	
	WRITE (7,260) ((1,X(1)),1=1,9) 260 FORMAT (15HOINITIAL STAYE://(3H X(,11,4H) = ,G13.6)) WRITE(7,270) TORNTS(2)	
7 202 2787 22	WRITE(7,270) IDENTS(2) 270 FORMAT(1H0,47)	
190 -	- RETURN	
	C*************************************	
	300 CONTINUE	
195	C THIS IDENTIFIES THE BASIC RECEIVER STRUCTURE (THRHLD, OPT, SUBOPT) CAND REINITIALIZES, AS NECESSARY, THE FOLLOWING RCVR DATA .	
	CIR (NEGATE ONLY), NOAC, NOKLHN, NOLOE, BRCVR, DELBL, TETHRO IF (IR. GE. 5) GQGT(8,8) = GQGT88	
200	If(IR.GE.6) GQGT(9,9)=GQGT99 ITIT=HINO(IRCVR,2)	
	C NEGATE IR WITH THE FOLLOWING FOR NONADAPTIVE RECEIVER	
	IR=ISIGN(IR, IRSIGN)	
205	RETURN	
	C****************	
	400 CONTINUE	
210	WRITE(7,410) (IDENTS(I),I=3,4),IR,NG,NS	
	* 410 * FORMAT (1H0,A8,4HRCVR/1H0,A8,6HDESIGN/5H (IR=;12,4H,NG=,11,*** * 4H,NS=,11,1H))	••
215	WRITE(7,420) (IDENTS(I),I=5,6)	
	C RETURN	
tal talkultular talkapat graph and and an analysis and an anal	C*************************************	٠
220	500 CONTINUE	
	C THIS SETS-UP THE MSET-LOOP RETURN	
	C	
225	C	
	C THIS SETS-UP THE LG-LOOP FOR THE (MSET)-TH SERIES OF SETS	

" SUBROUTIN	E CONT	RL 1	73/17	2 ' TS '				FTN 4.6+4	152	05/18/79	13.43.29	, b	AGE	5
\$	·	RETU	r	, wa		4.4.0			***** * ** *** ***	erki kası dama Cina	* **** *******************************	·- ~ -, ·-	** ***	
	- C -						• ,	•		************				'
230	C****	*****	*****	*****	******	******	******	******	*********					
	_		-	-	· · ·		,	•					-	
	700	CONT		.										
	C 1H1	2 261:	INTIO(E K-LOOI	P FOR THE Køknøløli	E (LG)→T	H SET OF	KH SCANS'						
235		UPITI	1811UL 17.710	ON N	LE(I),I=1	, . 0 1								
20,	710	FORM	T (4H0	K •3X•6	HCSNRTO	5X.6HCSN	IRFR.3X.3H	OTY.3X.9(2X.	46.3X1/1					
		RETUI	RN					QTY, 3X, 9(2X,	, , , , , , , , , , , , , , , , , , , ,				•	•
	Ç					•								
	C****	*****	*****	*****	*****	******	*******	******	********					
240	C	0047	*****		_									
	800 C THY	CONT		S THE V	-TH SCAN	,		-					- •	
					4)=RHO+X(
		IF (K	EQ.KST	ART) NG	M=NG									
245		RETU	N -					****						
	C													
· · · · · · · · · · · · · · · · · · ·	C++++	*****	*****	******	*****	******	*****	******	******	, -,-	* **			
	C 900	CONT	MILE									. :		
250 .		CONT		0005666	S DATA ES	ONN THE	K-TH SCAN							
	- "			XS(2)			M-IN JCK		/					
			X (2)-X											
		COLB:	SQRT (P	PDIAG(2)) · · · · ·	7 1 1	** **	-				•		
			0 I=1											
255			-X(I)-		TAC (T)					* ******				
	910 -	00011			IAG(I)	,	v ./					·		
	720	IF (IS.GE.7	1 ES (7)	= ABSIX	7)1-485	(XS(7))							
		ÎF (S.GE.B) ES(8)	= . ABS (X	(8))-ABS	(XS(8))							
260		IF (NS	•GE • 91	ES (9) =	ABS (X (9))	-ABS (XS	(9))					5 a		
		SCANI	(R (K) ≖K		1=H	'	** *** * **		-			″∄		
			(K)=ES								3	ַ בּבּ		
			[(K)=ES {(K)=ES								္သ	` ₹		
265			(K)=ES							٠ ـ	· · · · · · · · · · · · · · · · · · ·	A		
				41/X(1)		•					- •	_		
		IF (N:	GE-71	EBETA(K)=180.*E	S(7)/PI					، د	1 2:		
		15183	401.401	EFALIK	140.24671	177771					- 1	~		
270		IF (N)	6-GE-91	EFSCOT	(K)=0.5*E	S(9)/PI					:	X		
270		TLIGH	(UN . NE .	N31AKI#1	AND . K . N.E .	KM) KEI	UKN	T-1.01	·		# F	k _{ri,}		
	920	EUSH.	17/1H	UI NJ 13.2/14.	. 610. 31.4	17.41.1Y	,9(1X,G10	I=1,9) ·			. ≼.>	-		
		-WRIT	7,93	0)-7H -	XS)(XS	(I),I=1	,NS)					g.**		•
		WRIT	(7,93	0) 7H	ERR, (ES	(I), I=1	.NS)	,						
275		WRIT	17,93	0)~7HSQ	(PII)	1SVAL(I)	•I =1 • NS) '					•		
	930	FORM	AT (1H	, 27X, A7.	1X,9(1X,	G10.31)				•				
			(7,1)						•			•		
	c -	RETU	,	.,	. ,									
280	C***	****	*****	******	******	******	*******	********	*******					
	-c · · ·	-						Nm 1		*** *** **** * **				
	1000	CONT	INUE											
· · ·	C THI	S SAV	S/PROC	ESSES/O	UTPUTS DA	ATA FROM	THE (LG)	-TH SET OF K	M SÇANS	• •				
		WKIT	106 د / ا :	u) (GQG	T(I,I),1.	1.NS1								

	13/2/6 13	FIN 4807492	03/10/19 1343424	FAUE 0
Camer terminal and an article and an article and an article and article article and article and article and article and article and article and article and article and article and article and article article and article article and article article article and article articl	•		, , , , , , , , , , , , , , , , , , , ,	· · · · · · · · · · · · · · · · · ·
295 1040 5	DOMETITO I IN THE LACT COURS BY OU			
1000 , 5	ORHAT(10(/), 18H ON THE LAST SCAN:,7X,9H	GUG1 (1)11)1X)9(1X)G10.	311	
	MIN=YMX=0.	i		
W	RITE (7,11)	•	•	
C	ALL INTIO (6H NRUN, NRUN, 1, 1)			
C	ALL PLOTRISCANNE, EALFA, KM, XNAHE, YNAH1,	YMTN-YMAY-O)		
296 6	ALL REALID(6H YMIN, YMIN, 1)	1,121,911,140,909		
2.70	ALL DEALTHIAL VOLU VOLV 44			
	ALL REALIG(6H YMAX, YMAX, 1)			
	MIN=YMAX=O.			
W	RITE (7,11)			
Ç	ALL INTIO (6H NRUN, NRUN, 1, 1)			•
295 C	ALL PLOTR(SCANNR, ETHET, KM, XNAME, YNAM2,	YKI N. YMAX. O1		
	ALL REALIG(6H 'YMIN, YMIN, 1)	**************************************		
ř	ALL DEALTOTAL VHAV. TA			
	ALL REALID(6H YMAX,YMAX,1)			
	MIN=YMAX=O.			
W	RITE (7,11)			
300 C	ALL INTIO (6H NRUN, NRUN, 1, 1)			
C	ALL PLOTRISCANNE, EALFR, KM, XNAHE, YNAHS,	YMIN, YMAX, O)		
· · · · · · · · · · · · · · · · · · ·	ALL REALID(6H YHIN, YHIN, 1)	THE PERSON NAME OF THE PERSON NA		
	ALL REALID(6H YMAX, YMAX, 1)		i	
	HIN=YHAX=O.			
			• (
	RITE (7,11)		·	
Ç	ALL INTIO (6H NRUN, NRUN, 1, 1)			
C	ALL PLOTR(SCANNR, ETHER, KH, XNAME, YNAM4,	YMIN, YMAX, O)		
C C	ALL REALID(6H YMIN, YHIN, 1) ""			
• C	ALL REALID(6H YMAX,YMAX,1)		•	
	MIN=YHAX=O.	•	. ,	
u	DITE (7.11)			
· · · · · · · · · · · · · · · · · · ·	ALL INTIG (6H NRUN, NRUN, 1, 1)			
ř	ALL PLOTRISCANNE, XFOUR, KM, XNAME, YNAMS,	VHTN. VHAV. AL		
	ALE TESTRISONATING APOSAGNISANATESTINATES	INAMP INAMPO		
	ALL REALID(6H YMIN, YMIN, 1)		همد	
	ALL REALID(6H YHAX, YHAX, 1)			
	F (NS.LE.6) GO TO 1065	•	• • • • • • • • • • • • • • • • • • • •	
	RITE (7,11)			
, , , , , , , , , , , , , , , , , , ,	ALL INTIO (6H NRUN, NRUN, 1, 1) ''''		- · · · · · · · · · · · · · · · · · · ·	
Y	MIN=YMAX=O.			• •
320 C	ALL PLOTR(SCANNR, EBETA, KH, XNAME, YNAM7, Y	HIN, YHAX, O) " " " "	** ** * * *** *** *** *** *** *** ***	• •
C	ALL REALID(6H YMIN, YMIN, 1)		•	
	ALL REALID(6H YMAX, YMAX, 1)			
	HIN-YHAX-O.			
	RITE(7,11)			
	ALL INTIO (6H NRUN, NRUN, 1, 1)			
	ALL PLOTRISCANNE, EFSC, KM, XNAME, YNAM8, YH	IN, YHAX, O)		
C	ALL REALID(6H YMIN, YMIN, 1)			
·· - C	ALL REALID(6H YMAX, YMAX, 1) " " " "	,	•	•
I	F(NS.LE.8) GO TO 1065			
330 ' · · · · · · · · · · · · · · · · · ·	HIN=YMAX+O.			
W	DTTC/7.111			
	ALL INTIG (6H 'NRUN, NRUN, 1, 1)		**** ** ** **** *** *** ***	
ř	ALL PLOTR(SCANNR, EFSCOT, KM, XNAME, YNAM9,			
		INTUL INTUL		
	ALL REALIDIGH YMIN, YMIN, 1)			
	ALL REALID(6H YHAX,YHAX,1) DHTINUE)		•
			,	
	F(.NOT.FILOUT) RETURN			
	KTIELLITTI		- + 1 + 1 + 1 + 4 + 4 + 4 + 4 + 4 + 4 + 4	
W	RITE(7,1070) (DATOUT(1),1=1,2) ORMAT(13H DUTPUT FILE ,2A10,1H:/)			
' 340 1070 F	ORMAT(13H OUTPUT FILE ,2A10,1H:/)			
	RITE(7,1072) DOUT, DELT, MTIMES, LGMAX, KM,	TODAY - JRNAH		
* * **	. ,	TOURIFUSING "" I'm "		

	300400111	E CONTRE	137112 13	,		FIN 7.0+722	02/18/14	13.43.29	PAGE	,
			ADMITTING						••	
			ORMAT(1H ; A10; 8		2X,13,10X},A10	0,8X,A10/}				
			RITE(7,1074) ID				. ,			
3.	45		ORMAT(1H ,6(1X,		0571 566 5666		-0			
3	13	1074 C	MATERIALUTOS MK	CONTRACTOR KHE	, REIN, PSC, PSCC	OT, BHLS, BRCVR, THESI	EP			
			ORMAT(1H , 12,3X		.					
			KH-HINO(35,KH-9	1)						
			0 1077 I=1,IKH							
-		1077 W	RITE(7,1078)EAL	LACTIVE LHEILT	1>EALLK(I1)EIH	ER(I),XFOUR(I)				
	50		DRMAT(1H ,5(G13	(4010X1)			_			
			0 1079 I=1,5	·			•	, ,		•
			RITE (7, 1080)							
			DRMAT(1H,5(6X,1	.H. + 11X}} " ' '			10 //11 12 //1111			
			M3=KM-3							
3 :	55		O 1081 I-KM3,KM				٠.			
			RITE(7,1078)EAL							
	1.7 114 41 20.			MAX,OTHO,TDRO	,BETAO,FSCO,E8	ETAO, EBETA(KM), EFS(00,			• -•
			FSC(KM)							
		1083 'F	DRMAT (1HC,9(G1	.2.6,2X11"		-,	· · · · · · · · · · · · · · · · · · ·			*
36	50	W	RITE(17) DOUT, D	ELT, HTIMES, LG	MAX,KM,TODAY,J	BNAH				
		W	RITE(17) IDENTS	KSTART		•		•		•
		W	RITE(17) NRUN,O	SNRDB, RHO, BET	A,FSC,FSCDDT,B	MLS, BRCVR, THESEP				
• •	• •		D 1090 I=1,KH				•	- 11		
		W	RITE(17) EALFA(1), ETHET(1), E	ALFR(I), ETHER(I).XFDUR(I)				
36	55	1090 C	DATINUE -							-
		W	RITE(17) RHOMAX	OTHO, TORO, BE	TAD, FSCO, EBETA	D, EBETA(KH), EFSCO,	FESC			
		- CK	K)				····			
		R	EWIND 17					•		
			X=IATTACH(6LTAP	E20.DATDUT)		• •	~	يت ر ج مصد . ما ج مع		
37	70		ALL RETURN (6LTA				•			
			F(IX.NE.O)'GD T			- '				
			X=ICATALO(6LTAP		W. ARHTGHETII.	21 RP . 3651				
			0 TO 1096		, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	ECITI FOOD				
			X=ICATALO(6LTAP	ETT.DATOUT.21		21 DD. 2651				·
3.	75	1096 1	F(IX.NÉ.O) CALL	INTINIAUTYC	11. TV.1.11	2CKF # 303 #		,		
	. •		F(IX.NE.O) STOP			TYCEACTODYA				
			ALL RETURN (6LTA		**! **	TASEAGISKIP				
			RITE (7,1099) (. 21			£ 65 10 10 10 10 10 10 10 10 10 10 10 10 10		
						, CATALOGED AND CLO		7 78		
21	30	1077 [ETURN	I LIFE SEWIAN	DOU TO METITEN	> CATALOGED AND CLU	12501	ా నో		
5 (•	r K	EIUKN					. ര്≝		
		Canasas	*****	****				ద≷		
**************************************			- , , , , , , , , , , , , , ,		,	**************************************	, 	RGINAL POOR		
		1100 0	ONTINUE							
38	16			1001TBUTC 0474	500H TUE 4866	T. TH 050755 05		√ 0 -∞ '		
- 50					tkun int (mat	T)-TH SERIES OF "		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		
			SETS OF KH SCAN	15				PAGE QUALD		
		- · · · · · · · · · · · · · · · · · · ·	ETURN	-		• •	- ,	F- 77		•
		. C.						⇒ ''`		
		TU F FT	a a a alamananan	***** * * ***		*** * * * * * * *	* * ********		•	
3 9		Ç						The feet		
• •			ONTINUE .			•				
			EFFECTS CLOSURE	OF THE SIMUL	ATION RUN					
	•		RITE (7,11) "		· · ·- ·	,	•			
		R	ETURN			,			•	
39	75	· C · · · ·				,				
		C *****	*****	*****	*******	********	**			
		C		, .	,					
		E	ND							

SUBROUTINE CONTRL 73/172 TS FTN 4.6+452 05/18/79 13.43.29 PAGE 8 45000B CM STORAGE USED 11.349 SECONDS

PROGRAM ML	551M 73/	172 TS		FTN 4.6+452	2	05/17/79	14.50.06	PAGE	1
care hazantum summer A y		•	·* ·		• •	. 454 % 244 % 44444			
			- · · · · · · · · · · · · · · · · · · ·	UT, TAPE12, TAPE15,			PM 4 HE		
	**************************************	PUT, TAPE17, TA	PE201		و ميزة				
	REAL LAMD								
			DAC, KALHAN, LDE, T	ETHRD, MORE					
5		DOATA/IDNRS(6			m		······································	·	
			HAMIN, TS, TR, DMEG						
			MAX, DELBL, NGM, IR						
			THO, TORO, BO, WSCO						
				K,KH,TETHPD,NG,NS,J	JN			.,	****
10			9),GOGT(9,9),H(6						
				6), RDIAG(6), PHDIAG(
				6,6),PA(9,9),LAMDA((6)				
		VR07/T(130),V				•			
			, ESLOE(9), ES(9)			,			
15		VRO9/BRCVR, BB							
		VR10/XS1(9),X		O.TUODOT.D.USC.WECC	not				
				R,THRDOT,B,WSC,WSCO					
			NRF, DSNRDB, RHO, B NR, LG, TPKT, TPKF	ETAJESUJEGNAX					
20				AT(2),XD(9,2),YD(4,	. 21		,		
20			MTIMES, MSET, MDR		,				
. ,	Chaunnektut	3004/011639000) n i i ne s y n se i y n o k	.					
10	CONTINUE								
	CALL MLSS	iig	•			*** ****** ***	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		
25	IF(MORE)								
4.5	STOP	90' 10 TA	4.		•				
	END			, ,					
		· · · · · · · · · · · · · · · · · · ·		* - * * * * * * * * * * * * * * * * * *	· 1				
OOOB CM STORAGE U	SED	-131 SECONDS							
0000 CH. 310KAGE 0		_4131 30001103	. ,		*		···································		

-• -	SUBROUTINE	MLSSUB	73/172	TS		'- SFTN 4.64	+452	05/17/79	14.50.06	PAGE	1
		• ••	an Jane 10 %			,	,				
	. '	¢ı	JBROUTINE ML	21122							
•••			EAL LANDA	2200	•	•	, ",		,		
				אחות א	NOAC, KALHAN, LOE, TE	THRD. MORE	4.2				
					THAMIN, TS, TR, OMEGA			• ••	2, 2,2,1,4,4,0		,
5					GMAX, DELBL, NGM, IR,		M 44 E				
					DTHG, TDRO, BO, WSCO, I				•		•
	_	, _ ,C	DMMON/RCVR03	/PI,F(9	9},FL25(4),FSAHP,K;	KM, TETHRD, NG, 1	. MLezn		, we was same		
](9),GQGT(9,9),H(6,						
					NÖKLHN, NOAC, GAMES (6			-			
10					(9),RMAT(6,6),PHI(6	,6),PA(9,9),LAI	MDA(6)				
			DHMON/RCVRO7								
					9), ESLOE(9), ES(9)						
			OMMON/RCVR09 DMHON/RCVR10					•		·· ··· · · · · · · · · · · · · · · · ·	
15					HE,THEDOT,ALFAR,THR	. THROOT. R. UST. I	USCOUL				
					CSNRF, DSNROB, RHO, BE		M30001,	•			
					SNR, LG, TPKT, TPKF	INFIDUPEDIAN					
					(4,2),FL10(4),DELTA	T(2).XN(9.2).YI	N(4.2)				
					BB, MTIMES, MSET, MORE						
20			AL SIMULATIO	IN: OPT	IMIZATION OF MLS RE	CEIVERS FOR			· ·		
11-63		C	MULTIPATH	ENVIRON	HENTS	, ,					
	-		IMENSION X1(9).INDE	K(2)+Y(4)+X(9)		5				
		Ε	QUIVALENCE (THAMAX	Y(1)},(ALFA,X(1})	/ A 611	* 1 20 4 21 22				
		C		.		•	. *				
25		C FOLG	BEGINS EXEC	UTABLE	STATEMENTS		•			•	
			I2=2.*PI								
٠,			12=2.4F1 022=SORT(.5)	•			-				- "-
		ر ع	055-20K1(0)		•						
30		Č F	OLG INITIALI	ZES THE	DIAGONAL OF F(8,8)	- ·					
•		č .			*						
•		9 D	0 10 I=1,9		•	•				•	
		, F	(I,I)=1.					,			_ , .
			ONTINUE		,						
35			ALL CONTRL(1		•		,	** * * * * * * * * * * * * * * * * * * *			
		` S	SQZ=SIGHA+SQ	ORT(2.)							
		Ç					DUD 4 DV				
				UNPLEIL	S INITIALIZATION AN	D COMPOSES SEC	UNDAKY				
40			PARAMETERS.		•			٠		- •	
40		, u	0 15 1*1*4								
•	•		L10(1) - FL10A	AECT. IAE	,						
			DATINUE		•						
			D 20 I=1,4						, -		
,45		. Y	(I) PYO(I, IAE	E)							
. •			OHLIŰÑE								
			MEGA#-(THAMA		N}/TS 🗻 , 🛴						
			ECPD#1./OMEG		.						
		_ 1	F=TS+TR-2.*1	THANIN+S	ECPD ",,			•			
50		C 5010	ADE CONCTANT		Tene Hero by b					•	
		C FOLG	WE COUPIANI	FARADE	TERS USED BY P						
		L D	BB=2.4/BMLS								
			UM=GAUSS(1.0	ງ) ້	*** * ***** ** * *** *** *** *** ***	•					, , ,
55		_	LPHA=10. ** ([0.)			•			
,			0(1, [AE) = ALF		- - • • •				,, ,	•	
			LPHAR=RHO*AL		4-				_		

SUBROUTIN	E MLSSU	JB 73 /	172	TS			FTN 4.6+45	2 ,	05/17/79	14.50.06	PAGE	2
				en e			*** ** * * ****					
+c = -+ ++		XO(4, IAE)			_		-					
60		XU(7, IAE)			۱.			t a				
		XU(8, TAE) TSAMP=1./	#P127 PS1MP	, , , , , , , , , , , , , , , , , , ,	-							
		DELT-DELT	ATIIA									
		F(2,3)=DE										
65	•	F(5,6)*DE F(7,8)*DE		• •		,	٠			······································	· ·····	
		F(7,9)=0.		T**2 .								
		F(8,9)=DE										
		JM1=JM+1 JM2=JM/2		•	,		~~					
70		TWW2=0.5*	TSAME	*{JM2+1	.)							
	-	00 30 I=1			-			•		,		
	`30 -	X(I)=XO(I	, IAE	٠				*****				
		CALL CONT	RL (2))				, <u> </u>				
75	C	-										
	C FOLO	G CALLS RE	CEIVE	R FOR I	INITIALIZAT	ION .	•	,				
	C	K # D										
MARCO AM 1 C 1022	• • •	CALL RCVR	,			100 3004 7 1	• •	+				
80 ,,	C FOLL	DUTUS 556	THC C			LGMAX RUNS O	5 KW 661W6 5				······	
	Ç	.UNING BEG	TM2 2) TUOPVIT	UN PEK SE)	LGMAX KUNS U	F KP SCANS E	ALH				
		CALL CONT							*** * ** ****			
as		DO 777 MM MSET=MMSE	SET=1	LAMTIMES						······································	· 	
85	c	W2F1=WW2F	1									
	•	CALL CONT	RL(6)	}					~,, / 2 = 1, 2 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4			
· ·		DO 1 LGG=	1, LGM	MAX, ,							·	
.90		LG=LGG CALL CONT	R1 [7]	\								
		DO 2 KK=1		· -	n 10 cm			4 p. es p. ess.		······································	·	
	^	K=KK	-		, , , , , ,				·			
	L	CALL CONT	R1. (8)	1								
95 - ´		IF (K .EQ			.22			,				
± .	Č.	. collawin	آها ٥	ANCES T	HE TOUE OF	ATE AND SAVE	DD 700 V41 W5				····	
	C			ANCES I	ne ikue si	ALE AND SAVE	PRIOR VALUE					
		00 100 I=	1,9			7 7-11-11		ORIGINAL OF POOR	7.			
. 100		X1(I)=X(I X(I)=0.)_ ,					" ਨ	***********			
	100	CONTINUE					<u>-</u>	又等				
, , , , ,		00 120 I-						85				
105	a -1	DU 110 J= X(I)=X(I)		Jisvee				为下		*****		
107	110	CONTINUE.	,,,,,	,0,7,0	,			0.70				
	120	CONTINUE				,		ころ		/		
	· .	8 = PVALUE (B, PI,	0.)				三流				
110	C FOLG	SETS THE	S PRI	OR TO C	COMPUTING S	AMPLE TIMES		PAGE TS				
		THES=XS(2)+DEL	.T*XS(3)		,		15 K				
	122	IF(.NOT.T	ETHR	o) GO TO	124		•	'##" "				
	122	CONTINUE	• •									

Ş	JBROUTINE	MLSSI	18 7	3/172	T S					FTN 4.6+4	52	•	05/17/79	14.50.06		PAGE	3
115.	-		xs1(1)•	.X{T}=Fi	, . n(T)	** *** *	• • •	** -			•						
			CONTINU	ΙE		, ·			•		•	16.00		201 b 7 4 4 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			
		124 C	CONTINU														
120		C FOLG							LATÉD QUA		-117 -4	~_ ,	*-14 * *				
	• -, -	C			¥: TPM	or cuns	IANIS	חו אט	E PRESENT	I SCAN	•						
125			ALZ=ALF	AR**2				•	•	•			,				
125.			AA2=2.4								tess 100 0	********	-				
				HES-TH.		3	n					•					
	•	•	TZT=TPS		714- I HE	31+36661	,				•	٠,٠		·			
	_		TZF=TPS									•					
130		C FOL	G COMPUT	ES FOR	THIS	KTH SCAL	N THE	SIGNA	L PEAK T	MES TPKT.	TPKE	AND					
		C THE				-NOISE	RATIO	CSNR	(K) .								
				((2)-TH.			_					**		ı			
-		c	I PKF# I I	+ CIHAM	IN-X (2))*SECPI	D				88.3	. 1	, ; .				•
135		C C	THAJET	AATPKT	1=1121	BY DE	CTNTT	T ON			ROOS	-					
	•	Č PJ±1				1.0,BY					ð:	مين					
			SIMILAR				· - · ·	,		•	-3				<u> </u>		
		С										MP**		-			
140		,	PRJOVAL	.S(X(5).	-X(Z))	E # II S C D D	TATOU	T 1 + T D V	T. DY. O. N		÷.	٠ -		*			
170			RF*PVAL	UE (B+()	WSC+0.	5#W3C00.	I # T D K.	IJTIPK Ti#TPK	T,PI,O.) T,PI,O.)								
•						(BT)+AR			.,,	•		-	**** *****	·		*	
						(BF)+AR			a) , , , e = r		, Jensey I	., .,,		·	 	· - 	
			CSNRT=S														
145		-	CSNRF=S			*					•						
			CSNRHX.	AMINI(
	•	•	CSNR=CS		CSIKIF	COUVE				٠							
				SNRMX-	CSNRMN											······································	
150		C															
	• •	C FOLO		TES A . E SAMP			PUTE	SAMPLE	TIMES AN	1D (LINEAR	} .	٠	* ^ ** **				
		С.	DO 130	J=1,JH.	2												
155	. ,	,	TINCR .		_ ′		,										
			JFR=JM3														
			INDEX				,								****		•
		e sou	INDEX (G COMPUT	(2)=JFR		ucc											
160		C PUL	JJ=TZT+		PLE 11	ne\$.							• • •			,	1 -
			T(J)=T.														
	•		T(JFR)		NCR			•					,,			•	
			THAJ=TE					u					, ,				
165			PJ=PMLS	LS(THR-									•				
102	•	C FOL	G COMPUT			SAMPLES		••		• •							٠,
			00 127	I=1,2	I - A				: .								
				(I) X3OP		Ι'									•		
170				F(JVAL)			•	**					,				
170				22*GAUS 22*GAUS													

SUBROUT	THE MESSUR	73/172 15	,	FIN 4.0+452	05/17/79 14.50.06	PAGE	· ·
2 2-ht 20	0J•	CAL=PVALUE(B+(WSC+0.5 AL2*(PJ**2)+AA2*PJ*PR				/	
175	SOF	'AMAX1(QJ,0.0) TQ2=2.*SQRT(QJ) QJ+SQRTQ2*XNC+XNC**2+	·xns**2				
	V(J	IVAL)=SSQ2+SQRT(UJ) ITINUE	- 1-1				
180	C	TINUE COMPUTES RECE	IVER RESPONSES		10 (1) 11 1212-1212		
به و های این به این به به این به میشود میشود میشود میشود میشود این به این به این به این این به این این به این این به این این به این این این این این این این این این این	C	L RCÝR			1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -		
185	С	DLÍOWING ASSIMILATES D	ATA FROM THIS SCAN	FOR FUTURE EVALUAT:	(ON ,	·	
		L CONTRL(9)					
190	C FOLLOW	NG ASSIMILATES DATA F	ROM THIS LG-TH SET	OF SCANS	1 30 k) 30 kom renski men saman (1) saman		
		LL,CONTRL(10), '	٠٠ ••	v v v			14
195	C FOLLOWI	ING ASSIMILATES DATA F	ROM THIS MSET-TH SE	RIES OF LGMAX SETS	OF KH SCANS		
		L CONTRL(11)					
	C FOLLOW:	ING , CLOSES_THE,, SIMULAT	ION RUN		***** ** ***** ********************		
	RE	LL COMTRL(12), TURN)		#***** H	· · · · · · · · · · · · · · · · · · ·		• •••••
				•, • • • • •		# # # # # # # # # # # # # # # # # # #	
. , , ,	- •	135 mg 40 th AR 18 40 T			4		

FUNCTION	AHT N	73/172	TS		FTN 4.	6+452	05/17/79	14.50.06	PÄGE	1 ·
	, , , 'FI	T)AHT, NOITONL	· ·	,	,	,	** * *** *** * *			
	Ç ·	THE PARAMETER	S OF THE SC	AN WAVEFORM H	AT LOCAL SCAN ENCE THE IDENT	ITY OF		*		*****
. 5	С ,	AS FOLLOWS:			COMMON AND ARE		•			
	C .	TS=DURATION (IF THE TO SC	۸N	REES IN A TO-F Rest interval	KU SCAN ,,				
10	C THAMA		E AT BEGINN	ING OF TO SCA		-				
handstip Angels of his exp and in his had				TE, DEG/SEC, DU	RING TO SCAN			<u> </u>	*	
. 15		DMMON/RCVROO/ 11=TS+TF	MAHT (XAMAHT	IN, TS, TR, OMEG	A, TF	• •				
#**) AN AT W. THE R. D. P. W. A.	т.	IF(T:GE.O.O) HA=THAMAX			,	are fri to took				
20		RETURN IF(1.GT.TS)0 HA≖THAMAX+DME			r			1		.
	100	RETURN IF(T.GE.TF)	• •							
	1	HA=THAMIN RETURN	•	• •	*					
., 25 .		IF(T.GT.Tl) HA=THAMIN-OME		,			4			
		XAMAHT = AH	• •							4 100411 4711111
30		RETURNEND	• • •	F1 % 4 48	un promi de cerm			·		
41000B CM STORAG	GE USED	.114	SECONDS '	,	• • •	1.4	,	4		

	SUBROUTINE OFLT	R1 73/17	72 TS		F	TN 4.6+452	05/17/79	14.50.06	PAGE	1	
			-								_
· · · ·		SUBROUTINE DIMENSION ((4)	(+C)	`		P				
4		S=X-C(3)+C(Y=C(1)+S+C(C(4)=S	(2) +C (4)				•	,		*4	
-	, and an a f	RETURN END								,	_
, 410000	CH STORAGE USE	D ,	,046 SECONI	s	•	•	(+ a' = =================================				
	. , ====			. , ,		PM 44 9196 9199 1				· · · · · · · · · · · · · · · · · · ·	_
-					3 <u>} </u>	•					
								<u></u>	<u></u>		

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BLOCKDATA MES		73/172	TS			FTN	4.6+452		05/17/79	14.50.06	PAGE	1
			•	•	,	**** 1	, , ,					
 .		DATA ML	S									
	REAL L											
• • • • •					LHAN, LDE, TE	THRD, HORE						
R			/IDNRS(
m pilot upon men na banapan sama	COULDN	I A R C V R O I	MONINA	IGNAX, DE	LBL, NGM, IR,	1AE				·····		
	COMPON	1/KCVK02	/RHUMAX,	DIHUJID	RO, BO, WSCO,	NSO(6), NGO	(6)			•		
	COMMON	14664803	/PI) F (9)	9) FL25	(4) FSAMP K	, KM, TETHRD	NG NS JH .		,			
	CONNON	17867804	/UEL1)EL	1(4))646	T(9,9),H(6,	91,1COUNT,	SIGMA					
10	COMMON	17864802	/ NULUE . N	UKLANIN	DAC, GAMES (6	JJRDIAG(6)	PMDIAG(9)					·-
10 ,	CONTROL	17 K L Y K U C	/BRCVR, E	YIAKUWI	(6,6),PHI(6	,61,PA(9,9	} LAMDA(6)					
					NRDB,RHO,BE			- 1	····			
	COMMON	1445 2001	/C3NKI)(3NKF 2 U 3	.10(4),DELTA	IAPPSCALGE	A X					
• •	COMMON	1/MLS003	ALTIONE (O. RTING	S, MSET, MORE	1121, 1019,	21110(4,2)		-			•
15					DSNRDB/20./	NUO / E /						
	DATA	SITATI.	.27611 3 61	01.0000	91358/,SIGH	KNU/+3/			- +			
					35 · 0 · • 0 · •							
	*				0.,2.,0./	J.,	· ·		*********		·····;	
	DATA Y				333E-3,6.6E	_2				, i		
20			1.533333			-3,						
					0.,0.,	,					•	
			831,.348			•	•	* ***				
					KH/100/,FS	AMD /1 . ACR /						
	DATA H	/16+0	124	0.1.6	+0.,1.,12+0	112#0.	.1.1					
25	DATA N	SD/2.8.	6.3.8.9/	NGD/2	5,4,2,6,6/		***					
,			1/,E0/9*		*, ',',',',',',	•			****	***** ** ***** ***		
			0./.PA/8									
• • • • • • • • • • • • • • • • • • • •					DRD/0.0/,80	/0-0/•4500	/0-0/	•				
	DATA N	OLDE/.T	RUE . / . NO	KLHN/ F	ALSE./, NOAC	/_TRUE_/				,	.	
30	DATA I	AE/1/.F	SC/51.30	/ BETA/	-168.0/,LGM	AX/1/			*** ** **** * ****			
* 1	DATA B	MLS/1.0	/ BRCVR/	1.0/.MT	IMES/1/, MOR	E/.TRUE./				•		
,		DNRS (5)					PA.				··· / ··· ·· · · · · · · · · · · · · ·	-
	END	,								•		
			•		••					,,	PER DEN S 1700 4000 0	

SUBROUTIN	IE RCVR	73/172 TS	, ,	FTN 4.6+4	52	05/17/79 15.08.35	PAGE 1
		SUBROUTINE RCVR REAL LAMDA, MJM2				••••	,
5	,	LOGICAL NOKLMN, NOLOE, NO COMMON/RCVROO/THAMAX, TO COMMON/RCVRO1/NGMIN, NG	HAMIN, TS, TR, DMEGA	., TF			, , ,
-	1	COMMON/RCVRO2/RHOMAX,D COMMON/RCVRO3/PI,F(9,9 COMMON/RCVRO4/DELT,ED(THO, TDRO, BO, WSCO,), FL25(4), FSAMP, K	NSO(6), NGO(6) , KH, TETHRD, NG, NS	JH .		
10		COMMON/RCVRO5/NOLOE,NOI COMMON/RCVRO6/PPD1AG(9 COMMON/RCVRO7/T(130),V	KLMN,NDAC,GAMES(6),RMAT(6,6),PHI(6	1, RDIAG(6), PMDIA			
		COMMON/RCVRO8/XSLOE(9); COMMON/RCVRO9/BRCVR,8B; COMMON/RCVR10/XS1(9),X	,ESLOE(91,ES(9) ,PDCRIT,CC		,		
15 ,		DIMENSION TPA1(9,9), PH DIMENSION RVNG(6), GAIN		IVING(6)	* ** **	4	
,, <i>t</i>	C ENI	IF (K .GT. 0) GO TO 40	** 1 2 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4				
20	0 100	PI2=2.*PI SS2=.5/(SIGMA*+2)	•		•	. , ,	
	_	CALL PHILM NS=NSO(IR)					- 1 t h- 44
25	_	NG=NGO(1R) NCMIN=2				,	
		NGMAX=NGO(IR) GQGT33=.01*DELT			,	1	
		GGGT(3,3)=GGGT33 GGGT(6,6)=GGGT33		PM - 4 + 214		New Action of the second discountry of the sec	
		GQGT(8,8)=.04/(DELT**2 DD 20 1*1,NS DD 10 J=1,NS					
- · · · ·	10 20	PA(I,J)=0. CONTINUE CONTINUE		, , , , ,			*
		CALL CONTRL(3) BB=2.4/BRCVR					
	- ,	PDCRIT=PI*BB/8. CC=PI*PDCRIT					
40		IF(IR.GT.O) GD TD 30 NS=NSD(4)			Ja Turan ya k	#4FF - # \$1886, 44() #4864444444444444444444	
	30	NG=NGO(4) CONTINUE NGM=NGMIN	** **			n	
45		IF(NDAC) NGM=NG KALMAN=.NOT. NOKLMN	F	***			
hiện hệ là diện (Amilyana		LOE - NOT - NOLOE	o so restricted to the second section of the section of the second section of the section of the second section of the section		F F 4 20100 1 1,000	PM C V9 Addition in the Control of t	
50 °	40 .	RETURN CONTINUE					*
•	C	IF(K.GT.1) GD TO 50					
	C DIA	SNOSTIC OUTPUT OF INPUT	DATA_FOR_K=1.GDE	5, HERE	. Humfer	F107344 VP10500 White dalable hiddelink gain, again, again, again, again, again, again, again, again, again, ag	
55	50	GO TO 90 CONTINUE G Extrapolates_state_es:	TIMATE, AS DEA A	•	•	TO SECURE OF THE SECURE OF	
	C LUL	PENTRAPULATES STATE ES	ITHURIEN "WO" KEAND '		•	*	***************************************

OPRVR6 Page 1 of 4

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20	

SUBROUTIN	E RCVR	73/172 TS	FTN 4.6+452	05/17/79 15.08.35 PAGE 2
•		IF(16THRD) GO TO 80	-	
60		DG 70 I=1,NS XS1(I)=0.	•	
00		DO 60 J=1,NS		مو میرو ب سم و بر یا معامد د
	~60```	XS1(I)*XS1(I)+F(I,J)*XS(J), CONTINUE	يعمي عد خامينوو ا امخامه والمختلف	
65	70 ₋ 80	CONTINUE	•	
7	90 C	CONTINUE		T T I THE THE WEST WITH MET AND A MAN MARK MET TO A TO A STATE OF THE
		. GQGT11=AMAX1(.25,.01+(XS1(1)++2)		* 4 Mark market to the state of
70	_	GQGT(1,1)=GQGT11 GQGT(4,4)=GQGT11		
* *	C NG)	LOWING COMPUTES VECTORS Q(JH), HW , PHI(NG,NS) ALSO SQUARED AMPLITUD VATION; S PROCESS VECTOR W(JM)		OTCJH,,
75	C	THIS INDUCES TO THE MENT	**	pred we re an annual annual and annual annua
		CALL PHILM IF (NOLDE) GO TO 120	•	
	C = 0;	C COMPUTES BRITADUT THURBS IND T	CUE A DE	
80 ,	~ FUL	G COMPUTES RMAT=PHI-INVERSE AND T CALL MATINV(RMAT,6,NG,IVNG,RVNG)		
		DG 100 I=1,NG		
•	100	RDIAG (I)=RHAT (I,I) CONTINUE		
85		CALL MATMUL (6, NG, NG, 6, NG, 1, 6, 1, CALL MATMUL (6, NG, NS, 6, NG, 1, 9, 1,	RMAT, LAMDA, GAMAES, 1)	
		DD 110 I*1,NS		* N 2 1-1- 1-1-1-1 (1-1-1-1-1-1-1-1-1-1-1-1-1
•	110	XSLDE(I)=XS1(I)+ESLDE(I) IF (NDKLMN) XS(I)=XSLDE(I)		
90	110 120	CONTINUE CONTINUE IF (NOKLHN) GO TO 170	•	
	C,	TE CAUCERA'S GO (G 170		
	C	FOLLOWING EXTRAPOLATES STATE ES	STIMATES, ERROR	
95	Ç	COVARIANCE MATRIX PA(NS,NS)		gr. der 1986 Andrik der Produc Cartenquarks mehr mannen dem unig von septe un un ge-
		CALL MATMUL(9,NS,NS,9,NS,NS,9,9,9,CALL MATMUL(9,NS,NS,9,NS,NS,9,9,9,		
	~ ,	CALL MATSM(PA,PA,GQGT,1,9,9,9,NS	3,NS,9,NS,NS,O)	
.00, ,	130	PMDIAG (I)=PA(I,I)		
	C	CONTINUE		
-	C	FOLLOWING COMPUTES MODIFIED-KAL	.MAN GAIN MATRIX GAIN(NS,NG)	* * * * * * * * * * * * * * * * * * *
05	С "	CALL MATHUL(9,NS,NS,6,NG,NS,9,6,	PA-H-PHT-21) and a series were not not assume the analysis and analysis of the first and analysis of the first and analysis of the first and analysis of the first analysis of the first analysis of the first and analysis of the first analysis of the firs
* ** **	•	CALL MATHUL(6, NG, NG, 6, NG, NS, 9, 9, CALL MATHUL(9, NG, NS, 9, NS, NG, 9, 9, 9,	PHI,H,TPA1,1)	The second secon
•		DO 140 I=1,NG TPA2(1,1)=TPA2(1,1)+1.	e de la composition de la comp	• J
10	140	CONTINUE CALL HATINV(TPA2,9,NG,IVNG,RVNG)		e ()
	С	CALL HATHUL (9, NS, NG, 9, NG, NG, 9, 6,	PHT, TPA2, GAIN, 1)	
		FOLLOWING UPDATES STATE ESTIMAT	*	

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115	CALL MATMUL (9,NS,NG,6,NG,1,9,1,GAIN,LAMDA,ES,1)
	CALL MATSM (XS,XS1,ES,1,9,1,9,NS,1,9,NS,1,0)
	· · · · · · · · · · · · · · · · · · ·
	C FOLLOWING UPDATES STATE ESTIMATE , ERROR COVARIANCE MATRIX
	.C P(NS)NS)
120	C
	CALL MATMUL(9,NS,NG,9,NG,NS,9,9,GAIN,TPA1,TPA2,1)
	00 150 Imlans
	150 CONTINUE
125	CALL HATHUL(9,NS,9,NS,9,NS,9,9,PA,TPA2,TPA1,3)
	CALL MATMUL(9,NS,NS,9,NS,NS,9,9,TPA2,TPA1,PA,1)
	CALL MATMUL(6,NG,NG,9,NS,NG,9,9,PHI,GAIN,TPAI,3)
	CALL MATMUL(9,NS,NG,9,NG,NS,9,9,GAIN,TPAL)TPAC;1)
	CALL MATSM(PA) PA) TPA2,1,9,9,9,NS,NS,9,NS,NS,0),
130	DD 160 I=1,NS
	PPDIAG (1) *PA(1,1)
	160 CONTINUE
	170 CONTINUE
	XS(1)=ABS(XS(1))
135	AN=(THAMAX+THAMIN)/2.
	XS(2)=SATU(XS(2)-AN,(THAMAX-THAMIN)/2.)+AN
	IF(NS.GE.3) XS(3)=SATU(XS(3),1.)
	IF(NS.GE.4) XS(4)=SATU(ABS(XS(4)),2*XS(1))
	MJM2=FLDAT(-(JM/2+1))
140	THWWZ=HJMZ*OMEGA/(2.+FSAMP)
	AMX~XS(2)+THWH2
	SWWHT-(S)2X-NAA
	IF(NS.GE.5) XS(5)=SATU(XS(5)-AN2,(AMX-AMN)/2.)+AN2
145	IF(NS.GE.6) XS(6)=SATU(XS(6),1.)
	IF (NS.GE.7) XS(7)*PVALUE(XS(7),PI,O.)
	IF (NG.EG.5) XS(8)*PVALUE(XS(8)*PI/DELT,0.)
•	RSMAX*8000.
	IF(NS.GE.9)_XS(9)=SATU(XS(9),RSHAX)
150	RETURN
	END
41000B CM STORA	GE_USED1.412 SECONDS
	_
	A list is an extremely and described to the first fixe. Although the second is the first is a fixed in the second is the second in the second
	4 1 W W 4 4 F F F F F F F F F F F F F F F F
	·
	,
 	The state of the s

BLOCKDATA ORVRID 73/172 TS FTN 4.6+452 05/17/79 15.08.35 PAGE 1

BLOCK DATA ORVRID COMMON/IDOATA/IDNRS(6) DATA IDNRS(4)/2/ END

41000B CH STORAGE USED .012 SECONDS

SUBROUTINE	PHILM 73/172 TS		FTN 4.6+452	05/17/79	15.08.47	PAGE	1
	SUBROUTINE PHILM	. , , , , , , ,		,	4 *F * T ! 3 W		
	: THIS OPTIMAL VERSION OF AND PROVIDES A CRUDE S ACCESSED AS FOLLOWS:				. 1	- •	4
	SEARCH MODE: NGM=N	NGMIN.LT.NGM.LT.NGMA					
10 (••	• •					
	THIS _NEEDS NGMIN.	LE.NGH (.LE.NG) .LE.N	NGMAX,				
	COMMON/RCVR01/NGMI	.DE, NOAC, KALHAN, LOE, TE N, NGMAX, DELBL, NGM, IR, IAX, DTHO, TDRO, BO, WSCO, (9,9), FL25(4), FSAHP, H	IAE NSO(6),NGO(6)	· · · · · · · · · · · · · · · · · · ·			·
20	COMMON/RCVRO4/DELT COMMON/RCVRO5/NOLC COMMON/RCVRO6/PPD1	T,ED(9),GQGT(9,9),H{6, DE,NOKLMN,NOAC,GAMES(6 LAG(9),RMAT(6,6),PHI(6	9),ICOUNT,SIGMA 5),RDIAG(6),PMOTAG(9)			
,		1E(9), ESLOE(9), ES(9)		,,		,	~
25	. COMMON/RCVRO9/BRCV COMMON/RCVR10/ALFA CWSCDOT,XS(9)	A, THES, THESDT, ALFAR, TH	IRS, THRSDT, B, WSC,				
		,DT(130,6),HW(130),W	(130)				
	FOLLOWING EFFECTS INIT	TIALIZATION TOTAL	464 ··· ·· ·· · · · · · · · · · · · · ·		***************************************		*********
30	IF(K.GT.0) GD TO 1 JM2=JM/2	10		THE RESIDENCE OF ANY PROPERTY OF THE PROPERTY			
	JM1*JM+1 SS2=.5/(SIGMA**2)		, ,	•• ••			
35	RETURN LO CONTINUE		n	*		,	
	FOLLOWING PROGRAMS THE	SEARCH	, , , ,	,		***************************************	
40,	IF (NGM.GT.NGMIN) ALFAR=ALFA*RHOMAX THRSOT=TORO	-		- 10 1000 000 000 0000			*1**
,, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	8=80 WSC=WSCO			y () proportion to the second of the second			
45	THRS=THES-DTHO FOLG TETHERS WSCDOT WSCDOT=0.				PP		
e name to quicking day also so common en -2 by	OCONTINUE	p – p kan yan ramang p yanpaman d d			· · · · · · · · · · · · · · · · · · ·		معرضه و بن
50	FOLLOWING COMPUTE	S CONSTANTS FOR PRESE	ENT SCAN				
	AL2*2.*ALFA AL22=AL2*ALFA	, , , , , , , , , , , , , , , , , , , 	•				
	AR2=2. +ALFAR AR22=AR2+ALFAR	A TELL OF THEOREM WE WINDOW WEREHOLDER W		,	r menganisak ng paraparaksi palitika dan dalah		
55 	AA2=AL2+ALFAR FOLLOWING_INITIAT	TES_LOOP_AND_COMPUTES	FUNCTIONS				<u>-</u>

PLOPT6 Page 1 of 4

	SUBROUTINE	PHILM	73/172 7	'S	, ,- , - ,		FTN 4.6+4	452	05/17/79	15.08.47	PAGE	2
	1											
		C	FOR EACH J									
	•	С			-		•					
60) , ,		DO 60 JI=1, JM2		'. ·		**	,				**
			INDEX(1)=JI							•		
			INDEX(2) = JM1-JI					,				
			THAJ=THA(T(JI))									
			THEE THES-THAJ		**	•	•					
6)		PJ=P(THEE)									
* * ***	10 11		PDJ=PDGT(THEE). P2J=PJ**2	-								
	•		res=rs++e Ther≖Thrs∸Thaj.		•							
			PRJ=P(THER)		1 77417 1 774	· · · · · · · · · · · · · · · · · · ·		// //				
70)		PORJ-POOT(THER)									
			PR2J=PRJ++2						• -	,		
			PPRJ*PJ*PRJ									
			ONRJ . 5 + ALZ2 + P2	J							,	
			CRJ = QNRJ+ . 5 + ARZ	2*PR2J							<u>_</u>	
7:	5		DINET=AL2+P2J									
			C1=AR2+PPRJ		•		•	• •		· -		
			D2NET=AL22*PJ*F									
•	•		C2=AA2*PDJ*PRJ	•								** D 24 .
A1	1		D3J=ARZ*PRZJ C3=AL2*PPRJ			,	•		•	,		
01	,		C3-AC2+PDRJ+F	,	- · ·	•	*	4 ** 77)				
			C4=AA2*PJ*PDRJ	NJ								
			D5J=-AA2+PPPJ			*						
			COMPLETES CALC	ULATIONS	FOR TOPE	RO SCANS. R	ESP.					
8 :			DO 50 1=1,2					/.			1-	•
			J=INDEX(I) "		, .		•		*****			
			TJ=T(J) .									
			BLOCAL = PVALUE (E	S+(WSC+0	.5+WSCDQT+	TJ}*TJ,3.14	15927,DELBL)			· ·	
_			SB=SIN(BLOCAL)								•	
90	,		CB×COS(BLOCAL) OJ=QNRJ				н -					
			QRJALL=QRJ-D5J:	re								
• • •			DIJ=DINET	- CB	•					·····		
`			O2J=D2NET									
9:	;		IF (NGM.LT.NGM/	X) GO TO	3 40						res for Y	
			QJ=QRJALL		,			_				
			D1J#D1J+C1*CB		-		•		, "			,
			D2J=D2J+C2+CB									
			CONTINUE									
100) '		DT(J,1)=D1J	•								
			DT(J,2)=D2J	a á			•			•		
	•		DT(J,3)=D3J+C3*			•		•	•	um at atm		
			DT(J,4)=D4J+C4*	FCB								
10	· · · · ·	-	DTJ5*D5J*SB DT(J,5)*DTJ5	•					* * * * * * * * * * * * * * * * * * * *			····
10.		c FDI	G IS FOR A 6D t	DE DEST	N.	٠	ů.					
	•	- ,,, 50	DT(J,6) = DTJ5+T.		•••	•			•		•	
		C FOLL	DWING COMPUTES	VECTOR I	dua (ML) Wi	INNOVATION	IS PROCESS VE	ECTOR WIJH)			
		C		- · · - · ·						****** * * * * *		
, 110) , ,		HW(J)*1./(1.+2.	.*QJ) .			, ,,		. ,,			
			61 ×4{ 1 }			7						
			UJ=SS2*(UJ++2)				•			, ,	,	
			W(J) = (UJ/SQRT()	L.+QJ*UJ	11-1.						.*	
		50	CONTINUE									

410008 CM STORAGE USED

```
115 ... 60 ... CONTINUE _
                     FOLLOWING COMPUTES VECTOR LAMDA(NG) AND MATRICE PHI(NG, NG)
                    DO 110 I=1,NG..
 120
                    LAMDA(I)=0.0
                    DD 70 J=1.JM
                    LAMDA(1)=LAMDA(1)+DT(J,1)+W(J)
               70
                    CONTINUE
                    00 100 L=1,I
                    PHILI=0.
                    DO 80 J=1, JM
                    PHILI-PHILI+HW(J)+DT(J,I)+DT(J,L)
               80
                    CONTINUE
              PHI(L,I)*PHILI
 130
                    PHI(I,L)*PHILI
                  IF (NOLDE) GO TO 90
                    RMAT(L,I)=PHILI
90 CONTINUE
135 ... 100 CONTINUE
               110 - CONTINUE
                   . RETURN___
                    END
                      " .823 SECONDS
```

BLOCKDATA PLOPID 73/172 TS

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PAGE

1

BLOCK DATA PLOPID
COMMON /IDOATA/IDNRS(6)
COMMON/RCVRO1/NGMIN, NGMAX, DELBL, NGM, IR, IAE
DATA IDNRS(3)/2/
DATA IR/6/
END

41000B CM STORAGE USED

.019 SECONDS

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